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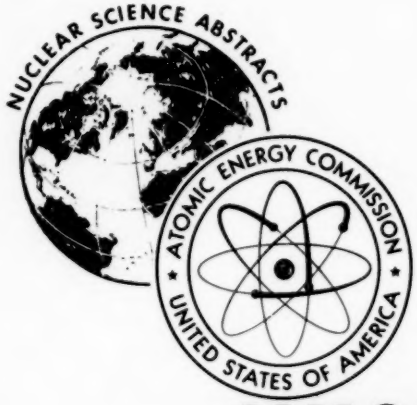

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NUCLEAR SCIENCE ABSTRACTS

BIOLOGY AND MEDICINE

General

36908 (A/CONF.28/P/874) LES TRACEURS EN BIOLOGIE. (Tracers in Biology). Carlos Chagas (Brazil. Universidade, Rio de Janeiro. Instituto de Biofisica). May 1964. 19p.

The uses of tracer techniques in studies of: the structure of biologically significant chemical compounds; metabolism; genetics and reproduction; partition and processes inaccessible to direct measurement; and pharmacological problems are studied. (T.F.H.)

36909 (A/CONF.28/P/853) RADIOISOTOPE STUDIES OF ADAPTATION TO RESIDENCE AT HIGH ALTITUDES AND TO HEAT STRESS. J. Metz, M. C. Path, and C. Wyndham (South Africa. Chamber of Mines, Johannesburg). May 1964. 10p.

Man's adaptation to environment may involve many physiologic processes, among the most important of which are changes in the body's fluid compartments. These changes in fluid compartments are often complex, and lend themselves particularly to study with radioisotopes. Results are reported of such studies of adaptation to two aspects of environmental stress, viz. residence at high altitude, and physical labor under conditions of extreme heat. These studies were carried out on normal healthy male subjects resident at an altitude of approximately one mile (5,740 ft) above sea level and the results compared to those of subjects resident at sea level. Multiple tracer techniques have been used including measurement of red cell volume with ^{51}Cr, plasma volume with ^{131}I albumin, total body water with $^{3}H_2O$, and total exchangeable sodium with ^{22}Na. Complex changes associated with residence at the higher altitude have been found. The red cell volume is increased and the plasma volume decreased; in this way the total blood volume is not appreciably changed. The body venous haematocrit ratio is raised. The total body water is similar at altitude and at sea level, but the total exchangeable sodium tends to be lower at the high altitude, and the serum sodium concentration thus reduced. Physical labor under conditions of heat is necessary in many industries, and study of man's adaptation to such conditions is of practical importance in the prevention of heat exhaustion and heat stroke. Studies have been carried out on normal volunteer subjects who performed physical labor in a heat chamber under conditions of extreme heat and humidity. Multiple radioisotope techniques were used to measure plasma volume, total body water, and total exchangeable sodium. Studies included changes accompanying a single exposure to severe heat, as well as those following acclimatization to heat on successive exposures. While changes in plasma volume were not striking, marked changes in total body water and total exchangeable sodium were observed. Of particular interest was the comparatively long period required for re-establishment of equilibrium in the body's fluid compartments following exposure to extreme heat. (auth)

36910 (LA-3098) BODPRO II: ANALYSIS OF T_4-BACTERIOPHAGE ULTRACENTRIFUGAL BOUNDARIES. G. R. Shepherd, B. J. Noland, and P. N. Dean (Los Alamos Scientific Lab., N. Mex.). June 1, 1964. Contract W-7405-eng-36. 28p.

A detailed investigation was made of the effects of concentration, rotor speed, and boundary height upon ultracentrifugal sedimentation rates of T_4-bacteriophage DNA. All experimental data were submitted to a computer program (BODPRO) for computation and analysis. Boundary anomalies such as buckling, reversal, and intermittent rate changes were observed and found to be dependent upon concentration and, to a lesser degree, upon rotor speed. Sedimentation rates were observed to be dependent upon rotor speed at concentrations of 5 to 100 μg DNA/ml, though the degree of dependence lessened with increasing concentration. Sedimentation rates at all rotor speeds were found to be greatly dependent upon concentration, increasing with concentration to the region of 50 to 75 μg DNA/ml and decreasing rapidly beyond this point. Boundaries were observed to form and to migrate as increasingly vertical formations with increasing concentration to a point well beyond the linear response range of the technique. (auth)

36911 (UCRL-11387) BIOLOGY AND MEDICINE SEMIANNUAL REPORT, SPRING 1964. John H. Lawrence, ed. (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion). Contract W-7405-eng-48. 170p.

Separate abstracts were prepared for thirteen sections of this report. A list is included of publications during the period covered by the report. Four sections were abstracted previously in NSA, Vol. 18, as nos. 29180, 29414, 33940, and 36904. (C.H.)

For abstracts of individual papers see: 36912, 36913, 36914, 36922, 36923, 36924, 36925, 36953, 36954, 36955, 36956, 36957, and 37044.

36912 (UCRL-11387(p.1-6)) ENERGY REQUIREMENT FOR THYMINELESS DEATH. David Freifelder

and Ole Maaloee (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

Certain bacteria having a nutritional requirement for thymine lose viability when incubated in a growth medium, complete but for thymine. This has been termed thymineless death and is pertinent to studies of both replication and control of synthesis of DNA because only these cells in the act of DNA synthesis at the time of thymine removal are sensitive, i.e., lose viability. This means that the system here out of control is active or its site of action is available only during the period of allowed DNA synthesis. The precise conditions for thymineless death have caused controversy principally because the distinction between the above-mentioned sensitive cells and the remaining (inter-synthetic) immune fraction has not always been made, leading to confusion between inhibition of death and interconversions of sensitive and immune cells. One proposed requirement has been that active metabolism is necessary to initiate the death process. This observation is confirmed and amplified in the finding that once initiated, continued loss of viability is still dependent upon an energy source. This places several constraints on possible mechanisms of thymineless death. Results are reported from studies on energy requirements for thymineless death in E. coli $15_{(\tau^-)}$ an auxotroph requiring thymine, arginine, and uracil. (C.H.)

36913 (UCRL-11387(p.54-60)) COMPUTER ANALYSIS OF SCHLIEREN PHOTOGRAPHS OF SERUM-LIPOPROTEIN DISTRIBUTIONS. Alicia M. Ewing, Amrita L. Bhattacharyya, Robert D. Wills, and Frank T. Lindgren (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

A method is presented for the computer analysis of lipoprotein distributions as measured in the analytical ultracentrifuge. The procedure, utilizing a minimum of input measurements from Schlieren photographs, allows not only the calculation of uncorrected concentrations but, in addition, provides for F versus C and Johnston-Ogston type corrections. Although this technique has been applied only to two specific lipoprotein run types, the method presented is quite general and can easily be used in analysis of other types of runs. Preliminary results achieved with this procedure indicate comparable or greater accuracy than that obtained by previous methodology involving manual planimetry of areas on the Schlieren photographs. (auth)

36914 (UCRL-11387(p.165)) STUDIES ON CHROMOSOMES BY MEANS OF SHORT-TERM LYMPHOCYTE CULTURE. William D. Loughman, H. Saul Winchell, and Myron Pollycove (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

In order to fully assess the ultimate value of methods used in obtaining homologous organ transplants, the relative degree of chimerism obtained in mammals must be known. Particularly, it is desirable to know whether the circulating lymphocytes are of donor or recipient origin. It is also desirable to know the time sequence of establishment or disappearance of donor lymphocytes, compared to the time sequence of clinical manifestations. This may be done by using donors whose sex is different from that of the recipient, and performing serial karyological studies. The karyotype of the dog was established in short term in vitro cultures of lymphocytes. Counts showed 78 chromosomes in both sexes, 75 of which are acrocentric of varying sizes, with one pair (#1) significantly larger than the rest. The female has two metacentric chromosomes about the size of #1, whereas the male has only one such metacentric. Scoring of cells as male or female (donor or recipient) is easily done by counting large metacentric chromosomes in intact cells. Investigation of the time sequence of proliferation of intraperitoneally transplanted spleen cells in dogs is reported in progress. Using the same short term culture technique, the lymphocytes of human patients with hereditary hemochromatosis were also karyotyped. In three patients studied, no obvious deviation from a normal karyotype was seen. Additional cases studied were familial spastic paralysis, acute lymphoblastic leukemia post-irradiation, and polycythemia vera (one case each). No obvious deviations from a normal karyotype were seen. Karyotyping of both dogs and humans is continuing, to permit statistical comparison of lab normals with experimentals, and to describe more accurately the chromosomes of the dog. (C.H.)

36915 UTILIZATION OF ISOTOPIC INDICATORS IN BIOLOGICAL RESEARCH. Rault (Hôpital de l'Armée, Paris). Rev. Corps. Sante Armees, 2: 385-403(1961). (In French)

The following topics are outlined: a brief history of radiochemistry, the principles of utilization of isotopes as indicators, and the principal isotopes used in biological research. With the last topic there is a table of the principal stable and radioactive isotopes used in biological research (H, C, N, O, P, S, Fe, I) with half lives and modes of decay. A discussion of principal techniques includes preparation of tracers, including stable isotopes and the preparation of radioactive isotopes. The review of labeled molecules includes illustrative syntheses of simple organic molecules (1-^{14}C-acetic acid, 2-^{14}C-acetic acid, deuteroformic acid) and brief mention of in vivo syntheses. Included in the topic of methods of measurement are outlines of methods for stable isotopes (mass spectrometry) and methods for radioactive isotopes (various counters, autoradiography). The preparation of samples includes mention of techniques for ^{131}I, ^{24}Na, ^{13}C, ^{2}H, ^{15}N, ^{18}O, ^{32}P, ^{14}C, and ^{35}S. Illustrations of their use are chosen from the fields of biological chemistry, physiology, and pharmacology and toxicology. (BBB)

Ecology

36916 (A/CONF.28/P/738) RADIOACTIVE FOOD CHAINS IN ARCTIC REGIONS. Jorma K. Miettinen (Helsinki. Univ.). May 1964. 12p.

Investigations of bioenvironmental radioactivity in the arctic regions of Scandinavia and Alaska revealed radionuclide food chains effecting high body burdens of strontium-90 and cesium-137 in animals and man. The most important of these food chains leads from lichens through reindeer to man and causes in reindeer-breeding Lapps and Eskimos up to one-hundred times higher body burdens of cesium-137 than the northern hemisphere average. (auth)

36917 (A/CONF.28/P/811) AN EXPERIMENTAL STUDY OF Sr^{90} CONTAINED IN MARINE ANIMALS FOLLOWING POSSIBLE RELEASE OF RADIOACTIVE WASTE IN SEA WATER. H. A. F. Gohar (United Arab Republic. Inst. of Oceanography), S. E. E. Hashish, A. Hassan, and K. Moulokhia. May 1964. 15p.

The kinetics of ^{90}Sr uptake into and release from soft tissues and shells of the gastropod Nerita Forskalii Recluz which contains normally high concentrations of strontium in the shell and is of ubiquitous occurrence throughout the Red Sea, the Indian Ocean, and the warmer parts of other oceans are discussed. (C.E.S.)

36918 BIOLOGICAL VECTORS AND RESERVOIRS OF STRONTIUM-90. Daniel J. Nelson (Oak Ridge National Lab., Tenn.). Nature, 203: 420(July 25, 1964). (ORNL-P-24)

The roles of emergent Chironomidae as vectors of ^{90}Sr and freshwater clams as reservoirs of ^{90}Sr in the Clinch and Tennessee Rivers were assessed. Fallout entering the Clinch River added 45 times as much ^{90}Sr as was removed by the emerging chironomids. Therefore, it was concluded that the general dispersion of ^{90}Sr by insects is not of great importance. Similarly, the annual removal and reservoir of ^{90}Sr in clams were small. It is suggested that general contamination of the landscape by mobile organisms is unlikely. (H.M.G.)

Metabolism, Tissue Distribution, and Toxicology

36919 (A/CONF.28/P/841) BIOLOGICAL DISPOSITION OF ANTI-BILHARZIAL ANTIMONY DRUGS. PART I. ESTIMATION OF ANTIMONY IN BODY FLUIDS AND PARASITES BY ACTIVATION ANALYSIS. A. A. Abdel Rassoul (United Arab Republic. Atomic Energy Establishment, Inshas, Egypt), M. F. Abdel Wahab, A. R. Schulert, H. G. Browne, and M. M. Mansour. May 1964. 11p.

Neutron activation analysis is applied for the determination of antimony in body fluids. This method is used for following the disposition of anti-bilharzial antimony drugs in biological samples. It consists of simultaneous irradiation of a standard and test sample (1.3×10^{13} n/cm^{2}sec), followed by dissolution and addition of Sb-carrier. In a single step, antimony is separated as the volatile hydride SbH_3, decomposed, and dissolved in H_2SO_4 before counting. The chemical yield is determined spectrophotometrically. The procedure is used for routine analysis of various samples with good reproducibility, and gives adequate decontamination of antimony from foreign activities. Independently comparative assays were performed in some samples which were already tagged to a slight degree with antimony-124, and the methods were found to be consistent. Measurements under the conditions specified can assay levels of about 0.01 ppm antimony in biological ash of plasma and red blood cell samples of treated patients with an accuracy within ±10%. The disposition of antimony drugs in man has been studied by the use of Sb-124 labeled material. Neutron activation analysis represents an alternative with the following advantages: the method is 10–100 times more sensitive than the radioactive assay when the radiation dose to the patient is within acceptable limits, the assay is accomplished with no radiation whatsoever to the patient, and the necessity of specially prepared labeled material is avoided. Results are reported for biological fluids and excreted ova from patients. Data are presented on the disposition of antimonial compounds which were not readily available in labeled form. (auth)

36920 (HW-82409) HANFORD WHOLE-BODY COUNTER ACTIVITIES FOR 1961–1963. D. N. Brady, ed. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 1964. Contract AT(45-1)-1350. 24p.

There were 987 Whole Body Counter measurements performed in 1961, 770 in 1962, and 2112 in 1963 for a total of 3869 during the 3 yr period. The maximum quantities of radioactive materials found in the persons examined were 132 ncuries of ^{65}Zn, 35 curies of ^{137}Cs, 3.8 ncuries of ^{24}Na, and 1080 ncuries of ^{239}Pu. These quantities are equivalent to 0.22, 0.12, 0.05, and 270%, respectively, of the recommended maximum permissible body burden for occupational exposure as listed in the National Bureau of Standards Handbook. The potassium body burdens were similar to those obtained during 1959 and 1960. The mean value of the pooled data for males was 0.9 g of potassium per pound body weight. The results of ^{137}Cs varied markedly throughout the 3 yr period showing seasonal variations of world-wide fallout from weapons testing. The mean body burden of ^{137}Cs decreased from the 1959 and 1960 values of 8.6 and 7.3 ncuries to a low of 5.1 ncuries during 1961, followed by 5.3 ncuries during 1962. The mean value increased during 1963 to 10.5 ncuries. (auth)

36921 (LF-15) THE BACTERICIDAL ACTIVITY OF THE SERUM OF HEALTHY BEAGLES. G. H. Meade and W. E. Clapper (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). June 1964. Contract AT(29-2)-1013. 15p.

A relatively simple method for testing the bactericidal activity of serum from beagles which gave reproducible results was found. Activity was measurable for a strain of Escherichia coli, but not for Pseudomonas aeruginosa, Proteus mirabilis, or Bacillus subtilis. The E. coli bactericidin was inactivated by heat, was not restored by the addition of guinea pig complement, nor augmented by adding complement to the unheated serum. Such serum activity is apparently part of the immune mechanism of beagles and may be important in relation to their ability to resist invasion of the blood stream by intestinal bacteria. (auth)

36922 (UCRL-11387(p.61-9)) CHANGES IN LIPOPROTEIN COMPOSITION FOLLOWING PROLONGED INCUBATION OF HUMAN SERUM. Carl S. Rehnborg and Alex V. Nichols (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

The major lipoprotein species (S_f 20-10^5, S_f 0-20, HDL) were isolated ultracentrifugally and their lipid compositions determined, following the incubation of nonlipemic human serum (serum glyceride concentration, 49 mg %) at 38 degrees C. In all three lipoprotein species, the molar concentrations of cholesterol and phospholipids were found to decrease, while those of the cholesteryl esters increased. The data indicate that during the course of the incubation some of the cholesteryl esters are released from the S_f 0-20 lipoproteins and, subsequently, are associated with the S_f 20-10^5 lipoproteins and the high-density lipoproteins (HDL). Although the total glyceride content in the serum remains constant, it decreases in the S_f 20-10^5 lipoproteins and increases in the HDL and the S_f 0-20 lipoproteins. The observed reduction in the S_f 20-10^5 lipoproteins is attributed to the transfer of glyceride to the other lipoproteins during incubation. The fatty acid distributions of the glyceride and cholesteryl ester fractions have been determined by gas chromatographic techniques. Significant changes are observed only in the glyceride fatty acids of the S_f 20-10^5 lipoproteins. (auth)

36923 (UCRL-11387(p.91-5)) RESPONSE OF MONKEYS TO ERYTHROPOIETIN OF RABBIT, SHEEP AND

HUMAN ORIGIN. Donald Van Dyke (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

Monkeys in whom erythropoiesis was suppressed (post hypoxic) showed a significant reticulocyte response to the administration of erythropoietin of rabbit, sheep or human origin. These results indicate that erythropoietin of primate origin is not required for stimulation of erythropoiesis in primates. (auth)

36924 (UCRL-11387(p.105-13)) RENAL AND RETINAL VASCULAR CHANGES IN DIABETES MELLITUS. John A. Linfoot. Larry W. McDonald. and Thomas L. Hayes (California. Univ.. Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

A comparative study of the renal and retinal lesions in patients with diabetic retinopathy was undertaken in order to determine the relationship between vascular changes and clinical findings in 20 patients who had been selected to undergo heavy-particle pituitary irradiation for progressive diabetic retinopathy. In examining the retinal lesions by fundus photography and the renal lesions by light and electron microscopy. a clear-cut correlation was found between retinal, venous. and arteriorlar changes and diffuse glomerular sclerosis, these lesions being present in all of the patients examined. Nodular sclerosis was prominent in only 1 patient. Electron microscopy in 10 patients revealed basement membrane thickening and mesangial deposits in all patients; the most prominent deposits were seen in the patient with nodular glomerulosclerosis. The electron microscopic findings could not be correlated with retinal lesions or changes in renal function probably because of the limited number of glomeruli that can be examined by this technique. The lack of fusion of foot processes in the presence of proteinuria appears to be a somewhat distinctive feature of diabetic nephropathy when compared to other causes of the nephrotic syndrome. No correlation between the presence of retinal microaneurysms and glomerular microaneurysms was found. Large amounts of retinal exudate were strikingly absent in this series of patients. The abnormal renal function tests correlate best with the presence of diffuse glomerulosclerosis, which is in agreement with other workers. Heavy proteinuria was associated with a markedly reduced creatinine clearance; however, lesser degrees of proteinuria occurred with normal or only slightly reduced glomerular filtration rates; reduced creatinine clearances were also seen in the absence of proteinuria. These preliminary studies indicate that there may be certain patterns to the retinal and renal vascular damage in diabetics with progressive retinopathy. (auth)

36925 (UCRL-11387(p.152-64)) ISOLATION AND ESTIMATION OF SERUM ORGANICALLY BOUND IODINE. II. AN APPLICATION FOR THE DETERMINATION OF PROTEIN-BOUND IODINE (PBI) OR NON-ANIONIC IODINE (NAI). Gilles La Roche, Dorothy Carpenter, and Ann Coxworth (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

A simple method for the isolation of serum organically bound iodine by deionization on an anionic-exchange resin is presented. Stepwise description of a modified microiodine method is presented in detail. The purity and testing of reagents used in these procedures are supported by an extensive and varied compilation of determinations. (auth)

36926 (AEC-tr-6398(p.49-58)) THE STATE AND PROSPECTS OF THE USE OF RADIOACTIVE ISOTOPES TO STUDY METABOLISM IN THE NORMAL AND PATHOLOGICAL STATES. Ya. Kh. Turakulov. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 46-?(1961).

Labeled-atom methods in the study of the metabolism of living organisms are reviewed. (R.E.U.)

36927 (JPRS-26056) STUDIES IN SELF-PURIFICATION OF CESIUM-137 FROM RESERVOIR WATER AND IN SOME SPECIES OF ALGAE. Translated from Byul. Mosk. Obshchestva Ispytatelei Prirody, Otd. Biol., 69: No. 3, 20-4(May-June 1964). 30p. (TT-64-41326)

An abstract was prepared for one section of this report. A second section contains information on the biochemical composition of some algae species. (C.H.)

For an abstract of the individual section see: 36928.

36928 (JPRS-26056(p.1-8)) SELF-PURIFICATION OF CESIUM-137 FROM WATER IN WEAKLY RUNNING RESERVOIRS AT VARIOUS SPEEDS OF FLOW, VOLUMES OF WATER, AND CONCENTRATIONS OF CESIUM. A. L. Agre, I. V. Molchanova, and N. V. Timofeev-Resovskii. Translated from Byul. Mosk. Obshchestva Ispytatelei Prirody, Otd. Biol., 69: No. 3, 20-4(May-June 1964).

Results are reported from a laboratory study of the biological purification of water from ^{137}Cs. The distribution of ^{137}Cs in water, sediments, and aquatic plants was measured as a function of the speed of flow of water, dilution, and concentration of Cs in the water. (C.H.)

36929 A COMPARISON OF ULTRASOFT X-RAYS TO HISTOCHEMICAL METHODS FOR THE DETECTION OF CALCIUM IN BLOOD VESSEL WALL. T. T. Tsaltas and B. O. Engfeldt (Uppsala Univ.). Acta Soc. Med. Upsalien., 68: 147-53(1963).

Data are presented comparing some generally used histochemical methods for detection of calcium in vascular tissues (von Kossa and alizarin) with ultrasoft x-ray microscopy. It is concluded that the x rays produce a picture that is in general agreement with the localization of histochemically determined calcium and that the histochemical methods tend to give much wider distribution of calcium. The x rays are considered to produce a more reliable and accurate quantitative picture. (auth)

36930 CELL DAMAGE IN DEUTERIUM INTOXICATION. Paul Bachner, David Rittenberg, and Donald McKay (Columbia Univ., New York). Am. J. Pathol., 44: 12a(June 1964).

Mice receiving 75% D_2O in their drinking water succumbed within 6 to 10 days. The animals developed a generalized pilo-erection within 24 hr and a generalized hyperactivity and combativeness within 48 hr. Occasionally convulsive episodes were observed in response to external stimulation. Eventually they became hypoactive, lethargic, and weak, with an increase in respiratory rate preceding death. At necropsy, local damage to the proximal convoluted tubules of the kidney was characterized by clumping and granularity of the cytoplasm and pyknosis of nuclei. Alterations were present in the larger excretory ducts of salivary glands. Duct cells had pyknotic nuclei and dense acidophilic cytoplasm indicating an early stage of necrosis. Ducts appeared to have separated and pulled away from surrounding acinar tissue. Demilunes of the parotid gland showed evidence of cell damage. Damage to the germ cells of the testis was indicated by maturation arrest with a decrease in mature spermatozoa. In addition to a decreased number of actively dividing cells, a few of the tubules contained bizarre giant

cells with 4 to 10 nuclei. The observation of renal tubular damage in the location of maximal water reabsorption is of physiologic interest. The ultimate damage to this tubular segment may be responsible for an unselective reabsorption of glomerular filtrate and account for the elevation of blood urea nitrogen. The destructive changes in the salivary gland ducts may be related to the fact that this is one of the few mammalian organs capable of concentrating D_2O. (BBB)

36931 COUNTING OF WEAK β-EMITTERS IN BACTERIAL CELLS BY MEANS OF THE LIQUID SCINTILLATION METHOD. Halina Y. Neujahr and Bertil Ewaldsson (Royal Inst. of Tech., Stockholm and Royal Veterinary Coll., Stockholm). Anal. Biochem., 8: 487-94(Aug. 1964).

Liquid scintillation counting was used to determine the ^{14}C and ^{35}S radioactivity of bacterial cells. A simple method for incorporating the cell material into the scintillation solution is described. This method involves the digestion of the cells with formamide and permits the incorporation of up to 10 to 11 mg cells (determined as dry solids) into 15 ml of a scintillation solution consisting of 10 ml 0.3% PPO in toluene and 5 ml ethanol. With smaller amounts of cells, viz., 6 to 7 mg, a simple autolysis of the cells at 60°C was found to be sufficient to bring the cell material into the scintillation solution. Various compositions of the scintillation solutions were investigated with respect to the counting efficiency of ^{14}C and ^{35}S in bacterial cells. (auth)

36932 THE BIOGEOCHEMISTRY OF THE STABLE ISOTOPES OF CARBON IN A MARINE BAY. P. L. Parker (Carnegie Institution of Washington, Washington, D. C.). Geochim. Cosmochim. Acta, 28: 1155-64(July 1964).

The most abundant biological samples from Redfish Bay, a shallow marine estuary near Port Aransas, Texas, were collected, and $\delta^{13}C$ for the total carbon, lipid carbon, and protein–carbohydrate carbon was measured. Some member of the community had an isotopic composition corresponding to every unit value of $\delta^{13}C$ between −6 and −17. $\delta^{13}C$ was found to be constant for different individuals of the same species to ±1/mil. The pure fatty acids or lipids, or both, were found to be from 0.5 to 15/mil lighter than the total carbon of the organism that contained them. The organic matter of the sediment could have been supplied by the community according to the carbon-isotope data. A 5/mil diurnal variation in $\delta^{13}C$ of the inorganic carbon of the sea water of a simple marine community was observed. (auth)

36933 ZINC-65 RETENTION BY AORTIC TISSUE OF RATS. W. H. Strain, F. Huegin, C. A. Lankau, Jr., W. P. Berliner, R. K. McEvoy, and W. J. Pories (Univ. of Rochester, N. Y.). Intern. J. Appl. Radiation Isotopes, 15: 231-7(Apr. 1964).

Zinc-65 retention values were determined for young and old, male and female rats over a period of 20 days. Special attention was given to the uptake of the isotope by aorta and hair. After 10 days the aortic tissue of all but the old male rats attained greater radioactivity per gram than the most active visceral organs, liver and pancreas. Age and sex have a definite influence on the uptake and retention by various organs. Older rats showed a delayed aortic uptake and a continued accumulation of the isotope in the hair. Females had a higher initial zinc uptake and greater overall hair zinc retention than males. In all but the old females, femur activity at 20 days was greater than liver. The results have bearing on the general problems of zinc metabolism. Discussion is presented on Zn:Ca ratios, as required for maximum growth and development in food-animals and humans; Cd:Zn antagonism; and the possibility of using hair as an indicator of the bone Zn level. (P.C.H.)

36934 THEORETICAL STUDY OF RADIOHIPPURAN RENOGRAM. M. Kutka, R. Gilardi, and L. Semprebene (Università, Rome). Intern. J. Appl. Radiation Isotopes, 15: 213-19(Apr. 1964).

A theoretical analysis of the simplified radiohippuran kinetics in organism, with regard to the radiohippuran renogram evaluation, is presented. The biological processes are characterized by rate coefficients. The theoretical influence of main processes, which are involved in the kinetics, was found on the form of radiohippuran renogram. (auth)

36935 DIGITIAL COMPUTER ANALYSIS OF HUMAN ISOTOPIC DRUG KINETICS. J. H. Nodine, J. M. Platt, J. Carranza, R. Dykyj, and Y. Mapp (Hahnemann Medical Coll. and Hospital, Philadelphia). Intern. J. Appl. Radiation Isotopes, 15: 263-8(May 1964).

The availability of digital computer techniques for the analysis of radioactive and stable drug data in obtaining kinetic factors permits more to be known about the absorption, distribution, metabolism, and excretion of various drugs that are now being used. This information permits conclusions to be made regarding dose schedules, to correlate duration of action with plasma levels and to predict drug accumulation with repeated dosage. The results of studies carried out to date have often revealed unexpected deviations that have been shown to be clinically important in considering drug action and dosage. (auth)

36936 THE BIOSYNTHESIS OF NICOTINE IN NICOTIANA GLUTINOSA FROM CARBON-14 DIOXIDE. FORMATION OF THE PYRROLIDINE RING. William L. Alworth, Arnold A. Liebman, and Henry Rapoport (Univ. of California, Berkeley). J. Am. Chem. Soc., 86: 3375-81(Aug. 20, 1964). (UCRL-11197)

Radioactive nicotine, isolated from the root and aerial portions of Nicotiana glutinosa after a 6 hr exposure to $^{14}CO_2$, was degraded and the activity determined in the pyridine ring, the N-methyl group, and C-2′ and C-5′ of the pyrrolidine ring. The results support previous conclusions reached from $^{14}CO_2$ feedings. In addition, equal activity was found at C-2′ and C-5′, consistent with the glutamate-symmetrical intermediate hypothesis. However, the labeling pattern required is not derivable from any of the known glutamate biosyntheses. An attempt was made to reconcile the various data by suggesting a new glutamate biosynthesis. (auth)

36937 AUTORADIOGRAPHY WITH TRITIUM LABELLED CELL PREPARATIONS: SOME PHYSICAL FACTORS AFFECTING IMAGE PRODUCTION IN TWO LIQUID NUCLEAR EMULSIONS. B. I. Lord (Royal Cancer Hospital, London). J. Phot. Sci., 11: 342-6(1963).

Using the dipping technique of liquid emulsion autoradiography, the effects of development time and temperature, emulsion dilution, and storage during exposure were investigated for two emulsions. The mean number of grains produced over labeled cells in tritium labeled cell preparations was taken as a measure of the emulsion's response. The initial test showed that five minutes was a suitable development time and all subsequent slides were developed for this time period. Further tests showed that for each emulsion there is an optimum development temperature, 16°C for Ilford K5 and 19°C for Gevaert 7.15, when the ratio of grains due to intranuclear tritium to background grains is highest. It is also shown that diluting the emulsions by about half with water does not impair

their efficiency. The stability of the latent image is found to be improved in the case of Ilford K5 by the presence of a drying agent during exposure, but the reverse appears to be the case for Gevaert 7.15. (auth)

36938 BOUND WATER, METABOLITES AND GENETIC CONTINUITY. S. J. Webb (Univ. of Saskatchewan, Saskatoon). Nature, 203: 374-7(July 25, 1964).

The mutagenic action of desiccation was investigated in Escherichia coli; and results were interpreted in terms on the mechanism of enzyme induction, protein and DNA replication, and the method by which the DNA code functions. Both bound-water and metabolites appeared to be involved, not only in preserving the viability of the cells, but also in preventing mutation. A definite amount of amino-acid uptake was necessary for the occurrence of DNA replication, in addition to a small lactose uptake. The role of bound water in maintaining the biological integrity of macromolecules was studied in mice inoculated with normal spleen and thymus cells either undried or dried for 30 min at 40% relative humidity. Both the number of animals with tumors and the total number of tumors were much greater in mice given the dried cells. Whether the observed increase in tumor incidence represented an acceleration of tumor development, or an actual induction, either by virus release or mutation, was not determined. However, the latter view was favored. It is suggested that the operational gene for enzyme production is a particular configuration on the outside of the DNA plus a given metabolite, and that in the absence of the metabolite the structural configuration is preserved by hydrogen-bonded water molecules which can be replaced by inositol or like compounds. If the particular DNA configuration is damaged by loss of water on desiccation or irradiation, the inner code is obviously affected when the two halves of the helix separate, resulting in deformed daughter DNA. It is pointed out that this hypothesis fits the facts known about gene expression and protein synthesis. Experimental results are explained in view of the hypothesis. (H.M.G.)

36939 EFFECT OF DEUTERIUM ON STARVING BACTERIA. S. Lovett (Microbiological Research Establishment, Salisbury, Wilts, Eng.). Nature, 203: 429-30(July 25, 1964).

Aerobacter aerogenes was used to show that deuterium oxide was not toxic under conditions of starvation and that the longevity of the bacteria was increased. Deuterium oxide was found to retard the rate of hydrolysis of RNA which is partly used as an energy source in maintaining the viability of the organism. It is suggested that after a certain proportion of the RNA is utilized, another process ensues that is not retarded by deuterium oxide. (H.M.G.)

36940 NUTRITIONAL IMPLICATIONS OF THE WHOLE BODY COUNTER. Gilbert B. Forbes (Univ. of Rochester, N. Y.). Nutr. Rev., 21: 321-4(Nov. 1963).

Applications of whole-body scintillation counters to studies of the nutritional requirements of various age groups are discussed. It is pointed out that measurements of the whole-body content of naturally-occurring ^{40}K in man have been used to determine lean body mass (LBM) and total body fat in males and females of various age groups. Data are reported from studies on age trends in LBM, K/N ratio during periods of rapid growth, Ca requirements during growth, and N balance during growth and senescence. It is suggested that the dietary need for protein may be well below levels recommended at present. (C.H.)

36941 USE OF ION EXCHANGE RESINS AND RADIOCHROMATOGRAPHY IN CHEMICAL-BIOLOGICAL RESEARCH. COMPLEX STUDY OF SULFUR METABOLITES OF BIOLOGICAL LIQUIDS AFTER ADMINISTRATION OF S^{35}-LABELED METHIONINE. I. Szantai, Z. Uray, M. Farcasanu, and V. Kovacs (Studia Univ.) Babes-Bolyai, Ser. Chem., No. 1, 395-8(1963). (In Rumanian)

The fractionation of urinary metabolites of ^{35}S-labeled methionine was studied in man and animals. After intraperitoneal administration of ^{35}S-labeled methionine, the global urinary elimination of the aminic fraction was determined, together with the keto-thioacidic fraction deaminated during the metabolic processes of the sulfurated amino acids. The aminic and keto-thioacidic fractions were then analyzed by radiochromatography. (D.C.W.)

36942 USE OF ION EXCHANGE RESINS AND RADIOCHROMATOGRAPHY IN CHEMICAL-BIOLOGICAL RESEARCH. II. MODIFICATIONS OF RF OF AMINO ACIDS AND SULFIDE AMINES-S^{35} UNDER THE INFLUENCE OF INACTIVE AMINIC COMPOUNDS EXTRACTED FROM BIOLOGICAL LIQUIDS USING AMBERLITE IR-120. I. Szantal, V. Kovacs, Z. Uray, and M. Farcasanu (Babes-Bolyai Univ., Cluj). Studia Univ. Babes-Bolyai, Ser. Chem., No. 1, 399-406(1963). (In Rumanian)

A method is proposed for identifying the sulfurated amino acids and for chromatographic analysis of the extracts of inactive amino acids obtained with ion exchange resins, following administration of ^{35}S-labeled methionine. (D.C.W.)

36943 THE EXCRETION OF THORIUM X AND ITS DAUGHTER PRODUCTS AFTER INTRAVENOUS INJECTION IN MAN. F. Schales (Max-Planck-Institut für Biophysik, Frankfurt am Main). Vienna, International Atomic Energy Agency, 1964, Preprint SM-52/59, 16p. (CONF-448-23)

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, May 1964.

Thorium X (^{224}Ra, 3.64 days half-life) has been widely used therapeutically since 1910. The main use today is for the therapy of Spondylarthrosis ankylopoetica in which 250 to 350 μc are injected intravenously in weekly doses of about 32 μc. The distribution of the gamma-emitting ThX-daughters in the human body was studied by means of a whole-body counter. Feces and urine were measured without chemical treatment under a big NaI-crystal in a mercury shield. The exhaled thoron was measured with a vibrating-reed electrometer arrangement. The measurements showed a rapid decrease of the body burden during the first 8 days, when about 40% of the administered Th X was excreted. After this period a rather slow excretion modus was observed. These results are compared with those of ^{226}Ra-poisoning cases. The decrease of the body burden, the amount of excreted Th X and Th B, and the exhalation of thoron was found to be in good agreement with the experimental values, in the first period by power functions, in the second period by exponential functions. An explanation of the power function model as a superposition of exponential functions is discussed. (auth)

36944 MEASUREMENT OF THE NATURAL CONTENT OF Th^{228}, Ra^{228} AND ITS DAUGHTERS IN THE HUMAN BODY. W. Stahlhofen (Max-Planck-Institut für Biophysik, Frankfurt am Main). Vienna, International Atomic Energy Agency, 1964, Preprint SM-52/60, 22p. (CONF-448-24)

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, May 1964.

Both the content and the distribution of the alpha emitters ^{226}Ra, ^{228}Th, and ^{210}Po were determined in the human body. The content of ^{226}Ra in human bones and soft tissues was determined by the emanation method, and the content of ^{210}Po by chemical enrichment followed by measuring the activity in a methane flow counter. The ^{228}Th content, as well as the total alpha activity, was measured by means of a specially developed scintillation method, the so-called mixing method. The content of ^{226}Ra in human bones and organs related to the patient's age was measured in order to get information on the incorporation of this nuclide at continuous administration of extremely low amounts. As to bones and soft tissues, the specific activity of ^{226}Ra in man was constant from the fourth month of pregnancy up to an age as high as 80 years. The content of ^{210}Po and ^{210}Pb in femur and tibia bones was measured in order to determine the ratio of ^{210}Po and ^{210}Pb in the human skeleton of living organism. This ratio is 0.8 on the average. The ratio of ^{228}Th and ^{226}Ra in human bone ashes is about 0.4. The age of the examined persons ranged from 5 to 70 years. As a result of these investigations the human radiation burden caused by the ^{226}Ra, ^{228}Th, and ^{210}Po content was estimated. (auth)

36945 MONITORING AND ASSAY PROCEDURES FOR KRYPTON-85 USED IN CIRCULATORY TESTS. Joseph M. Brown, Jr., and Kenneth D. Williams (Public Health Service, Bethesda, Md.). 14p. (CONF-337-38)

From International Conference on Radioactive Pollution of Gaseous Media, Saclay, France, Nov. 1963.

Krypton-85 is used extensively in the identification of circulatory shunts. Several methods for assaying the incoming shipments of radioactive gas are given. These consist of ionization chamber measurements, gamma ray spectrometry, and gross photon counting of the cylinder surface with an end-window Geiger-Mueller tube. A device, consisting of a log count-rate meter, recorder, and G. M. tube, is used to continuously monitor the laboratory. The method of calibrating this device is presented. A means for removing contaminated air from the vicinity of the operating table is described and the results of air clearance studies of the room are included. (auth)

Radiation Effects

36946 (A/CONF.28/P/386) GENETIC EFFECT OF SMALL DOSES OF IONIZING RADIATION. N. P. Dubinin, M. A. Arsenieva, Ya. L. Glembotskii, L. G. Dubinina, V. M. Kozlov, and V. A. Shevchenko (U.S.S.R.). May 1964. 20p.

Results are given of investigations on: (1) effects of fractionated doses of gamma rays, neutrons, and protons on lethal and sublethal sex-linked mutations in Drosophila, (2) cytogenetic radiosensitivity of meiosis in monkeys and mice, (3) effects of small doses on human cells in tissue culture, (4) protection against small doses by chemicals, and (5) mutagenic effects of ^{90}Sr in Chlorella algae. It is concluded that the genetic effects of small doses are cumulative and that no efficient chemical protection against such effects is possible. (D.L.C.)

36947 (A/CONF.28/P/856) THE EFFECT OF TRITIATED THYMIDINE AND GAMMA IRRADIATION ON THE MORTALITY OF DROSOPHILA MELANOGASTER LARVAE. Esin Kent (Turkey. Atomic Energy Commission. Cekmece Nuclear Research Center, Istanbul). May 1964. 6p.

It was found that tritiated thymidine and whole-body gamma irradiation (^{60}Co) increased the mortality rate of Drosophila melanogaster larvas, aged 72 hours, when applied simultaneously. When either was given to the larvas without the other, no comparable mortality rate was observed. (R.E.U.)

36948 (AD-438177) RADIATION EFFECTS UPON EXPERIMENTAL ANIMALS, MAN, AND PLANTS: AN ANNOTATED BIBLIOGRAPHY. VOL. II. M-Z. Jack B. Goldmann, comp. (Lockheed Missiles & Space Co., Sunnyvale, Calif.). Jan. 1963. 441p. (SB-62-60(Vol.II)).

One thousand and eighteen annotated references are presented to recent publications concerning radiation effects on experimental animals, man, and plants. An author index is included. (C.H.)

36949 (AD-438178) RADIATION EFFECTS UPON EXPERIMENTAL ANIMALS, MAN, AND PLANTS: AN ANNOTATED BIBLIOGRAPHY. VOL. I. A-L. Jack B. Goldmann, comp. (Lockheed Missiles & Space Co., Sunnyvale, Calif.). Jan. 1963. 441p. (SB-62-60(Vol.I)).

Over two thousand annotated references are presented to publications in English and foreign languages from June 1961 to June 1962 concerning radiation effects on experimental animals, man, and plants. An author index is included. (C.H.)

36950 (AED-C-04-15) RADIATION EFFECTS ON LIVING TISSUES AND ORGANISMS. Series C: Bibliographies. W. Stahlhofen, comp. (Max-Planck-Institut fur Biophysik, Frankfurt am Main). May 1964. 117p.

Four hundred and thirty-three references are presented to the international literature on the effects of radiation on living tissues and organisms. Author and subject indexes are included. (C.H.)

36951 (TID-20979) SUMMARY PROGRESS REPORT, 1952–1962. Richard R. Overman (Tennessee. Univ., Memphis. Coll. of Medicine). July 1962. Contracts AT (40-1)-283; AT(40-1)-1375; and AT(40-1)-1642. 57p.

Progress is reported in studies on the transcapillary movement of Na and K in dogs and monkeys; the effects of whole-body x radiation and other insults on capillary ionic permeability; the effectiveness of bone marrow transplantation as a therapeutic measure following acute whole-body radiation exposure of monkeys; and chemical protection against the effects of acute whole-body radiation exposure and the effects of repeated exposures to sublethal radiation doses in mice, dogs, and monkeys. Data are included on the pharmacological and radioprotective effects of AET and PAPP alone and in various combinations. A list is included of 33 publications resulting from research performed under these contracts. (C.H.)

36952 (TID-20979(Add.)) ADDENDUM TO SUMMARY PROGRESS REPORT, AUGUST 1, 1962–OCTOBER 31, 1963. Richard R. Overman (Tennessee. Univ., Memphis. Coll. of Medicine). Mar. 1964. Contracts AT(40-1)-283; AT(40-1)-1375; and AT(40-1)-1642. 128p.

The responses to locally increased muscular activity were investigated in normal control and irradiated dogs. Muscular contraction was induced for a period of 3 hr and responses were measured for 3 to 4 days after exposure to whole-body doses of 700 and 800 R x radiation. Results are reported from measurements of physiological changes in muscular work, mean arterial blood pressure, blood flow through the femoral artery, oxygen consumption of the contracting muscle, biochemical alterations in muscle, and the content of certain chemical constituents in blood. (C.H.)

36953 (UCRL-11387(p.7-14)) HEAT AS A MODIFYING FACTOR IN ENZYME INACTIVATION BY IONIZING RADIATIONS. Tor Brustad (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

Results are presented from a study of the radiosensitivity of dried trypsin, as tested by inactivation of the esterase activity at various temperatures after exposure to heavy ions of neon, carbon, boron, helium, and deuterons. The data indicate some shortcomings of the one-ionization model in its most restrictive form. It is shown that the degree of injury of dried enzymes exposed to ionizing radiations of various ionization density in all cases depends upon the sample temperature during the exposure. It appears that at least three different processes are involved, one that is temperature independent, and two that are temperature dependent, but distinguishable by different activation energies. In the simple one-ionization model, excitations are generally assumed ineffective. In light of the present data it does not seem impossible, however, that for $T < 100°K$ inactivation may be the result of ionizations within essential structures of the enzyme molecule. On the other hand, for $T > 100°K$ excitations may also contribute to the inactivation processes, perhaps by facilitating fast energy-transfer processes during the exposure. (C.H.)

36954 (UCRL-11387(p.25-34)) ANALYSIS OF THE EFFECTS OF HIGH-LET RADIATIONS ON VARIOUS BIOLOGICAL TEST OBJECTS. Cornelius A. Tobias and Paul W. Todd (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

Results are summarized from studies on the effects of environmental conditions on high-LET radiation effects. A number of unicellular organisms were exposed to monoenergetic heavy ions of 10 Mev/nucleon at various atomic numbers up to 18 (argon) under various environmental conditions. Quantitative cross section measurements as a function of LET led to a unified description of biological effects. Evidence is presented for the environmental modification of the biological effects of heavy ions. It is postulated that it might be desirable to use extremely high LET radiations to reduce the influence of modifying factors in tumor therapy. (C.H.)

36955 (UCRL-11387(p.35-53)) EFFECTIVENESS OF IONIZING RADIATIONS FOR INDUCTION OF MUTATIONS AND LETHALITY IN DIPLOID SACCHAROMYCES CEREVISIAE, IN RELATION TO IONIZATION DENSITY AND OXYGEN TENSION. Robert K. Mortimer, Tor Brustad, and Douglas V. Cormack (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

Progress is reported in studies on the relative biological effects of a number of heavy ion beams in yeast cells. Data are presented on the relation between RBE, ionization density, and oxygen tension for the induction of mutations and lethality in diploid cells of Saccharomyces cerevisiae. (C.H.)

36956 (UCRL-11387(p.127-39)) THE RELATIVE EFFICIENCY OF HIGH-LET RADIATIONS (BRAGG-PEAK LITHIUM IONS) ON NORMAL RABBIT SKIN, USING INTEGRAL DOSE AS A BASIS FOR COMPARISON. Giulio J. D'Angio, John H. Lawrence, Alexander Gottschalk, and John T. Lyman (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

Reactions in the skin of rabbit ears irradiated with single doses of Bragg-peak lithium ions of high linear energy transfer (LET) were contrasted to those produced by Bragg-peak deuterons with a comparatively low LET. Comparable volume doses were given with each. The dose-response curves for the two beams differed in configuration in the low dose regions. An RBE of between 2 and 4 was obtained for both acute and chronic reactions. Furthermore, dose-response curves indicated a sigmoid type curve for the low-LET radiations and a non-sigmoid curve for those with high LET's. These results on the skin of the living animal have reference to the greater RBE of high-LET radiations in the living animal and make, along with the relative absence of the effect of oxygen in such high LET radiations, these findings of interest with reference to the use of heavy particles in therapy of neoplastic and other diseases. (auth)

36957 (UCRL-11387(p.140-51)) BONE-GROWTH DISTURBANCE AS AN INDEX FOR R.B.E. INVESTIGATIONS— PRELIMINARY OBSERVATIONS. Giulio J. D'Angio, Alexander Gottschalk, and John T. Lyman (California. Univ., Berkeley. Donner Lab and California. Univ., Berkeley. Donner Pavilion).

A simple quantitative method for the study of radiobiological responses in living mammals is described. Asymmetrical irradiation of growing bone leads to angulation deformities that are dose-dependent. Mansuration of the angles resulting after such radiation can be used as an index of relative effects. In an illustrative preliminary experiment the deformity produced in rabbit bone by Bragg peak 910-Mev alpha particles was found to be greater than that resulting after 250-kv roentgen irradiation. (auth)

36958 (JPRS-25741(p.87-94)) INFLUENCE OF RADIATION ON THE RESPIRATORY CONTROL OF LIVER MITOCHONDRIA. Fu-yu Yang, Chin-chao Li, and Shu-hsiu Chang. Translated from K'o Hsueh T'ung Pao, No. 5, 441-3(May 1964).

Studies were made of the effects of up to 7×10^4 r x rays on the respiration control rate (ratio of respiration rates after and before addition of dinitrophenol (DNP)), the P/O value, and the adenosintriphosphatase (ATP) activity of isolated liver mitochondria. With succinic or glutamic acid as the oxidation base, the respiration control rate decreased with dose, while the P/O value remained relatively constant. The ATP activity induced by Mg^{2+} increased while that induced by DNP decreased with dose. The correlation of the changes in respiration control rate and phosphatase activity is discussed. It is observed that the radiation damage is similar to the effects of aging on mitochondria. (D.L.C.)

36959 DOES LIVER IRRADIATION MODIFY THE CARCINOGENIC PROCESSES OF DAB? A. Lacassagne (Institut du Radium, Paris). Acta Unio Intern. Contra Cancrum, 20: 573-4(1964). (In French)

Irradiation of the two lobes of exteriorized liver inhibited carcinogenesis. It was further concluded that the carcinogenic action of x ray and blood serum albumin are not synergistic. (H.M.G.)

36960 EARLY HISTOCHEMICAL CHANGES IN IRRADIATED SALIVARY GLANDS AND LYMPH NODES OF THE RAT. J. S. Greenspan, M. R. Melamed, and A. G. E. Pearse (Royal Dental Hospital, London). Am. J. Pathol., 44: 16a(June 1964).

The early sequence of events in cells injured by radiation may result in disruption of intracellular enzyme systems.

Because of the focal nature of radiation damage, histochemical techniques may offer certain advantages for further exploring this possibility. To compare changes in sensitive and relatively radioresistant tissues in close proximity and accessible to strictly local irradiation, the salivary gland-lymph node complex in the neck of the rat was used. A simple method was devised for lateral irradiation of these tissues without affecting other structures. Radiation doses of 2000 or 4000 rad were given to a total of 21 animals, which were then sacrificed at intervals up to 20 days. An additional 22 animals served as controls. A series of 23 histochemical reactions was investigated, including 16 for enzymes. Significant changes developed in several enzymes following radiation, and in the salivary glands these preceded morphologic evidence of injury. (BBB)

36961 COMPARATIVE RADIOSENSITIVITY OF EPITHELIUM AND ENDOTHELIUM. F. L. Jennings and R. A. Turner (Univ. of Texas, Galveston). Am. J. Pathol., 44: 17a(June 1964).

Ultrastructure studies in the experimentally irradiated lung have provided an opportunity to investigate degenerative and regenerative features of alveolar epithelium and capillary endothelium. The radiosensitivity of endothelium is well known, as are the marked proliferative changes and obliterative endarteritis seen as late sequelae of radiation. Radiosensitivity of alveolar epithelium is somewhat more difficult to evaluate since it is manifested principally as basal cell atypia. In the lung, epithelium and endothelium, each of different embryonic origin, are in close proximity and can be examined under comparable conditions. Presumably such factors as oxygen tension and tissue absorption, known to affect radiation dosage and effect, are similar in the alveolar wall. The rat lung was exposed to a conventional therapeutic radiation dose (4000 R). Electron microscopic examination showed that the endothelium suffered earlier, more profoundly and with more prolonged degenerative change than did alveolar epithelium. Within 6 days after irradiation, vesiculation and degenerative changes were apparent in the endothelium, and by 10 days much of it had been sloughed, leaving the basement membrane as the lining of the capillary. The alveolar epithelium showed slight cytoplasmic vesiculation at 14 days, but by 30 days these cells appeared entirely recovered and at no time was there epithelial sloughing. The endothelium exhibited progressive regeneration beginning at 30 days; by 100 days most of the capillary lining was restored and the cells appeared comparatively normal. (BBB)

36962 INDUCTION OF LEUKEMIA IN GERMFREE MICE BY X-RAYS. Morris Pollard and T. Matsuzawa (Univ. of Notre Dame, Ind.). Am. J. Pathol., 44: 17a (June 1964).

Germfree (GF) and conventional C_3Hf mice were given four whole-body doses of x rays (150 r each) at weekly intervals, starting at one month of age. They were examined frequently thereafter. At 7 months following the first dose of x rays, 14 of 26 (53%) GF mice and 7 of 21 (33%) conventional mice developed leukemia. The lesions in both groups of mice resembled those described by others in conventional animals. There was lymphoid infiltration of the enlarged thymus gland and, in most cases, of the spleen, lymph nodes, and viscera. Numerous cells were observed in mitosis in the areas of neoplastic involvement. This represents the first evidence of a disease-producing agent in germfree mice, and supports the proposition that x-ray-induced leukemia of mice may be perpetuated in the population by either transovarial or transplacental passage. (BBB)

36963 THE BIOLOGICAL ACTION OF HIGH-ENERGY (500-Mev) PROTONS. Yu. I. Moskalev and I. K. Petrovich. Bull. Exptl. Biol. Med. (USSR) (English Transl.), 55: 542-5 (July 1964). Translated from Byul. Eksperim. Biol. i Med., 55: No. 5, 73-7(May 1963).

A study was made of the biological activity of protons with an energy of 500 Mev, the range being from 28 to 1008 rad, a total of 10 doses. The LD_{50} was established for various periods. It proved to be 710 ± 45 rad for 15 days and 610 ± 30 for 30 to 120 days. A study was made of the relationship between the peripheral blood composition and the irradiation dose. The shape of the dose-effect curve for the peripheral blood cells depended on the follow-up periods and the properties of the blood cells themselves. (auth)

36964 CELLULAR EFFECTS OF IONIZING RADIATION. THE SEVENTH HARLOW BROOKS MEMORIAL LECTURE. Henry S. Kaplan (Stanford Univ., Calif.). Bull. N. Y. Acad. Med., 36: 649-61(Oct. 1960).

Recent advances in radiobiology are reviewed and the contributions that such studies may make through enhancing the efficacy of radiotherapy for malignant diseases are discussed. The limitations of chemotherapy of tumors are outlined and the concept that different classes of cells have different radiosensitivities is examined. Results are reviewed from studies on cells in vitro irradiated under various conditions, with emphasis on biochemical pathways by which the initial radiation injury is propagated. The effects of oxygen supply and chemical sensitizers and potentiating agents on the radiosensitivity of tumor cells are discussed Results using triethylenemelamine, octinomycin-D, and 5-fluoro-uracil in combination with radiotherapy for certain tumor types are reviewed. (C.H.)

36965 CONTINGENT RELATION BETWEEN THE RESISTANCE TO γ RADIATION OF CERTAIN ARTHROPODS OF THE SAHARA AND THE NUCLEIC ACID CONTENT OF THEIR TISSUES. P. Niaussat, A. Pascaud, C. Grenot, and F. Pierre (Museum National d'Histoire Naturelle, Paris). Bull. Soc. Med. Mil. Franc., 57: 295-9 (July 1963). (In French)

Several scorpions and coleoptera indigenous to the Sahara were irradiated with γ rays. The $LD_{50/30}$ (continuous whole-body irradiation) was found to be ~100,000 R for Androctonus amoreuxi and ~30,000 R for Pimelia angulata, compared with 60,000 R for Drosophila melanogaster and 20,000 R for Tribolium confusam. The relation between this high resistance and the content of tissue in DNA and RNA was examined. The scorpions (7 animals) were found to contain a mean of 11.35 ± 1.33 mg RNA phosphate and 1.02 ± 0.20 mg DNA phosphate per 100 g soft parts. For two specimens of Pimelia (imago) these values were 14.6, 15.6 and 2.41, 4.58, respectively. For comparison, the values for Drosophila larvae are reported to be 42, 53 and 2.92, 3.12; the salivary glands of Drosophila have values 33.8, 42.6 and 3.9, 4.2, respectively. These results do not permit conclusions but allow the question to be proposed: is there a relation between radiation resistance and the tissue content in DNA of an organism? These species studied all have low DNA values, and the morphology of scorpions has scarcely evolved since the Silurian period. The content of DNA in the venom is found to be practically zero. (BBB)

36966 A STUDY OF THE EFFECTS OF X-IRRADIATION AND PROTECTIVE AGENTS ON MICE USING Cr^{51}. P. V. Vittorio and S. Dziubalo (Defence Research Chemical Labs., Ottawa). Can. J. Biochem., 42: 1233-43(Aug. 1964). (DCBRL-435)

Using ^{51}Cr uptake as an index of radiation damage and recovery in mice, it was shown that all organs studied recovered from 100 R of x-irradiation during the experimental period (29 days). The kidneys recovered from 300 R, while the liver, spleen, thymus, lung, and duodenum were almost back to normal. The testes and heart showed evidence of considerable damage still existing at 29 days after 300 R. None of the organs recovered completely from 600 R during the same time period. Except for the first day after administration, the radioprotective agents used showed little or no effect on ^{51}Cr uptake in the organs of nonirradiated mice. S-2-Aminoethylisothioureadihydrobromide (AET), serotonin (5HT), or the mixture of AET plus 5HT appeared to aid the recovery of all of the organs studied except the testes, and the mixture of AET plus 5HT provided better protection than either agent used singly. The chromium method is especially useful since it permits a large number of animals and a wide variety of organs to be examined simultaneously. It can also be used to determine the value of radioprotective drugs or mixtures of drugs in protecting various organs of the body against different doses of x-irradiation. (auth)

36967 MUTATIONS INDUCED BY FRACTIONATED DOSES OF X-RAYS IN MAIZE POLLEN. Angelo Bianchi and Ferruccio Giacchetta (Università, Milan and Università Cattolica del S. Cuore, Piacenza, Italy). Can. J. Genet. Cytol., 6: 304-23(Sept. 1964).

Fresh maize pollen was irradiated during three summer seasons at room conditions using doses of 800 to 2500 r x radiation with intensities of 200 r and 2400 r/m (KVp 220 and 75, respectively). The same dose was administered either in a single continuous treatment or in two fractions separated by 1 to 2 hour intervals. The damaging effects studied were the rates of germless kernels, endosperm mutations, and a seedling trait. The genetic markers used were well known inherited factors of maize located in several chromosome loci, but most information was obtained from markers on the short arm of chromosome 9 and on the long arm of chromosome 3. Results showed that fractionation of the x-ray dose does not affect systematically the rate of the induced genetic damage; the breakage-fusion-bridge cycles were detectable in the endosperm at a rate which varied practically linearly with the dose; the same was true for the mutational event involved in the appearance of the yellow-green seedling class produced by the yg_2 factor placed on the terminal chromomere of the short arm of chromosome 9; all other mutations were induced at a frequency which increased more than proportionately to the dose; when such a frequency was relatively high (5 to 10%) a saturation effect appeared; the germless condition also showed a curvilinear dose-effect relationship; the endosperm mosaics (exhibiting both recessive and dominant tissues) formed more than $\frac{1}{3}$ of the total induced mutations; and although among the grand totals they appeared relatively more frequently in the fractionated treatments, these values were not comparable to the high frequency of mosaics detectable among the spontaneous mutations. (auth)

36968 IRRADIATION-PRODUCED CHANGES IN SEROLOGICAL PROPERTIES OF CERTAIN PROTEINS. S. Robev and S. Todorov. Compt. Rend. Acad. Bulgare Sci., 17: 259-62(1964).

The effects of 500 KR x radiation delivered during 38 hr on the serological properties of certain proteins and modifications in these effects induced by radioprotective compounds were investigated. The proteins included sheep hemoglobin, human serum albumin, and ovoalbumin as antigens and their antisera as antibodies. Cysteamine and N-phenylamide of thiophene-2-carboxylic acid were used as radioprotectors. A considerable radioprotective effect was demonstrated for both compounds for all three antisera with the amidine exerting 100% protection for antihemoglobin serum. The protective effect for the antigens was less pronounced. (C.H.)

36969 PROGNOSTIC MEANING OF THE CHANGES IN PERIPHERAL BLOOD DURING ACUTE RADIATION ILLNESS WITH HEAVY LOSSES OF BLOOD. D. Zografov. Compt. Rend. Acad. Bulgare Sci., 17: 303-6(1964).

The prognostical meaning of changes in the peripheral blood during acute radiation illness was studied in 39 guinea pigs, 20 of which were irradiated 30 min after a 25% blood loss; and the remaining 19, three days after the blood loss. The x-ray dose in air was 300 R. The results show that the only prognostic significance lies in the change in the number of erythrocytes in relation to reticulocytes during the second week after irradiation. Consequently, this limits the practical value of the prognosis since it cannot be used during the early stages of the illness. (OTS)

36970 EFFECTS OF SINGLE WHOLE-BODY γ IRRADIATION ON MACROPHAGES. A. I. Braude (Central Medical Inst. for Graduate Work, USSR). Dokl. Akad. Nauk SSSR, 155: 1188-91(Apr. 11, 1964). (In Russian)

Functional-cytochemical studies were made of macrophages extracted from the abdominal cavity of white mice exposed to single lethal doses and treated in vitro in order to determine the phagocytic activity of cells. The number of macrophages in irradiated animals was smaller than in control mice. The absorptive capacity and digestion functions were considerably depressed, but the phagocytic activity for microbes in the cell cytoplasm was not inhibited. Histochemical reactions indicate that an active acid phosphatase in lysates becomes somewhat higher than in control mice. The succinic dehydrogenase concentration in mitochondria was not affected, and the activity of nonspecific esterase remained at the same level for 5 to 6 days, followed by a partial drop in certain groups of macrophages. Correlations were made of the digestive ability and enzymatic activity of macrophages treated with cortizone and prodigiosine. (R.V.J.)

36971 RADIOSENSITIVITY OF NERVOUS TISSUE TREATED WITH ARSENIC COMPOUNDS. P. F. Minaev, O. F. Logvinova, A. P. Mironova, and A. I. Chukhrova (Inst. of Biological Physics, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 155: 1209-11(Apr. 11, 1964). (In Russian)

Variations in the radiosensitivity of nervous tissue were induced in 68 semimature dogs by injecting sodium arsenate (1 to 2 mg in 1 ml solution) into the cerebellomedullary cistern 2 hr before exposure. The experiments showed that oxidative decarboxylization of pyropyruvic acid is the most significant process taking place in irradiated nervous tissue. (R.V.J.)

36972 THE CHANGES IN SUBMICROSCOPIC CELL STRUCTURE OF BONE MARROW IN THE EARLY STAGES OF RADIATION SICKNESS CAUSED BY RADIOACTIVE STRONTIUM. O. A. Khomutovskii (Bogomol'ts Inst. of Physiology, Academy of Sciences, Ukrainian SSR). Dokl. Akad. Nauk SSSR, 156: 945-6(June 1, 1964). (In Russian)

The changes in a number of submicroscopic structures of bone marrow cell, which developed in the first 6 hours after injecting 0.32 $\mu C/g$ of ^{89}Sr and ^{90}Sr in white rats,

were examined in ultrafine sections of bone under an electron microscope. It is calculated that the dose to 1 gram of the femur bone is 6 rads (on introducing ^{89}Sr) and 12.6 rads (on introducing ^{90}Sr). One hour after introducing the ^{89}Sr and ^{90}Sr, the outer jackets of the megakaryocytes, the nuclei, and the ergastoplasmic membranes become unclear. The inner and outer jackets of the large mitochondria are broken up. Light spots appear in the center of the mitochondria. The state of the ribonucleicproteide (RNP) kernel changes by varying in size from 50 to 400 Å. The number of RNP kernels not in contact with membranes increases. These changes in the state of RNP kernels, which occur in the first few hours of radiation sickness, reflect the shifts that are taking place in protein synthesis. (TTT)

36973 REPARATION OF CHROMOSOME INJURIES IN RESTING LIVER CELLS OF RATS SUBJECTED TO CHRONIC GAMMA IRRADIATION. G. F. Palyga, S. P. Yarmonenko, and I. M. Shapiro (Inst. of Industrial Hygiene and Occupational Disease, Academy of Medical Sciences, USSR). Dokl. Akad. Nauk SSSR, 157: 460-3(July 11, 1964). (In Russian)

White rats were given an x ray dose 150 rads at a dose rate of 26 rad/min. The rats were also subjected to a total ^{60}Co γ dose of 150 rads administered continuously over periods of 15, 30, 45, 60, 90, and 180 days. Unirradiated rats served as controls. The percent chromosomal aberrations was determined by counting 100 cells at late anaphase or early telophase, and the mitotic activity was estimated from the number of mitoses per 100,000 cells. The percent chromosomal aberrations was 29.3% for the single dose of 150 rads, 21.8% for the irradiation over a period of 15 days, 21.2% for the 30-day irradiation, 19.2% for the 45 days, 16.2% for 60 days, 13.9% for 90 days, and 11.8% for the 180-day irradiation. The percent of damaged cells decreases with decreasing dose rate, and is practically the same as that observed in the controls (11.6%) after six months. The data indicate that reparation of cell injury takes place on decreasing the dose rate. Hence, radiation effects are not cummulative, but may be considerably ameliorated at low dose rates. (TTT)

36974 EFFECTS OF VARIOUS FACTORS ON OCCURRENCE OF MITOCHONDRIAL INCLUSIONS. O. A. Schjeide, Ruth McCandless, Myrna Wilkens, Marion Peterson, and G. V. Alexander (Univ. of California, Los Angeles). Exptl. Cell Res., 32: 379-90(Nov. 1963).

The occurrence of osmiophilic mitochondrial inclusions during embryonic development in two different tissues; their behavior under various experimental conditions (including direct and indirect x irradiation); and some new evidence pertaining to their gross chemical compositions are discussed. Livers and hearts from anesthetized chicken embryos, chicks, and adult chickens were fixed in situ with osmic acid. A trend was seen for liver mitochondria to contain more inclusions as functions of time and degrees of development up to 5 days posthatching. There was a decrease of inclusions to nearly zero in the mitochondria of newly hatched chicks. A depressive effect of 558 to 930 rad of whole-body x irradiation on inclusions of the liver mitochondria, which took place as early as two hr postirradiation, was shown. Liver mitochondria from 3-month-old rabbits also responded with decreases in granule content following x irradiation. The inclusions were observed to be largely absent from chick liver mitochondria 24 hr postirradiation; however, they were present in greater numbers again at three days postirradiation. A dose as low as 279 rad appeared to have little effect on the numbers of inclusions (this dose also failed to affect lipid metabolisms of the liver). When 930 rad was applied directly to the liver, no effect of the irradiation was seen. When, however, all of the body was irradiated, with the exception of a transverse band that included the liver, the usual decrease in population of granules was noted by two hr postirradiation. This result reveals that the effect of radiations on the granules is an indirect one. In addition to x irradiation, other conditions such as hatching, starvation, thyroxine treatment, increase of work load, and treatment with estrogenic substances, resulted in rapid dissolution of the granules in the mitochondria of liver (but not in heart mitochondria). The findings suggested a similar response of the liver mitochondrion to a variety of original stimuli. It is considered that this response may be triggered by similar homeostatic signals to the liver cell under conditions which can be described as stressful. The mitochondrial inclusions may consist of substances which are of unique use to the mitochondrion or cell under such conditions. Various, as yet unproven, speculations that these granules contain Na and K ions, lipids, and heavy metals are discussed. (BBB)

36975 EVALUATION OF THE FUNCTIONAL STATE OF THE PIG THYROID AFTER LOCAL IRRADIATION WITH X-RAYS. P. M. Kulyabko. Fiziol. Zh., Akad. Nauk Ukr. RSR, 9: 826-8(1963). (In Ukrainian)

Experiments with 42 pigs exposed to 2700 R of x radiation showed a high thyroid sensitivity to the radiation. Morphological changes in the gland caused histological and functional changes. The rate of ^{131}I uptake increased 3 to 7 days after the exposure, but it was considerably decreased 1 to 2 months later. X-irradiation induced degenerative tendencies in thyroid functions. (R.V.J.)

36976 CHARACTERISTICS OF TRACHEIDS PRODUCED IN A GAMMA AND GAMMA-NEUTRON ENVIRONMENT. John R. Hamilton (Univ. of Georgia, Athens). Forest Prod. J., [13]: 62-7(Feb. 1963).

High-level ionizing radiation in the environment, even in amounts considerably below that accepted as lethal, were shown to significantly affect the xylem structure of two Pinus species. Tracheid dimensions were reduced in P. rigida by 17.9% in length, 10.0% in lumen diameter, and 17.0% in wall thickness during an eight-year chronic exposure. Similar reductions were observed in P. echinata after exposure to radiation distributed over a one month period. In addition, disorganization of secondary tissues produced during exposure and a suppression of cell multiplication were observed. One possible explanation is that auxin synthesis or transport, with respect to the apical meristems, is destroyed by ionizing radiation. The recovery of trees exposed to sublethal doses was evidenced by subsequent normal cell formation and the occurrence of cell multiplication. This suggests that ionizing radiation did not cause permanent cytological damage. The resumption of normal cell multiplication and xylem organization during the time that apical meristems exhibited some external damage from radiation indicates the existence of other controlling mechanisms besides those related to auxin. It is postulated that vigor may influence susceptibility to ionizing radiation of Pinus species. The combination of 900 to 950 R and adverse climatic conditions apparently intensified the radiation effects. These observations are however, confounded by the fact that radiation has a cumulative effect. It is concluded that in the event that great quantities of ionizing radiation are released to the

atmosphere, damage to secondary tissues and modification of the normal within-tree pattern of variation in anatomical characteristics would occur at levels of radiation considerably below that required for mortality. (auth)

36977 BEHAVIOR OF GLYCOGEN IN EPITHELIAL TUMORS OF THE SKIN AFTER X-RAY THERAPY. Roberto Santini (Universita, Parma, Italy). Giorn. Ital. Dermatol., No. 2, 166-75(1963). (In Italian)

The glycogen changes which occur in some basal-cell tumors of the skin after x-ray therapy were studied. It was observed a light increase of this polysaccharide in the irradiated tumor cells, probably due to its lessened utilization, consequence of the arrested synthesis of nucleic acids, caused by radiations. (auth)

36978 THE GROWTH OF LACTOBACILLUS LACTIS IN IRRADIATED MILK. P. Dupuy (Institut National de la Recherche Agronomique, Station de Technologie Vegetale, Versailles, France) and G. Mocquot. Intern. J. Appl. Radiation Isotopes, 15: 255-62(May 1964). (In French)

Irradiation of milk with doses of up to 200 kRad promotes the growth of Lactobacillus lactis, as estimated by reduction in pH and increase of titratable acidity, whereas higher doses have an inhibitory effect. In the latter case a decreased maximum number of bacteria was also observed. Using irradiated milk or whey, it is shown that the reduction in growth is due to inhibitory substances formed during and after irradiation, rather than to a deficiency in growth factors. Further experiments in which irradiated lactose and casein solutions were added to nonirradiated milk showed that no inhibitory substances are present. Similarly, no difference was observed in the growth of L. lactis with varying fat content of irradiated milk. The possible use of microbiological techniques for investigation of biologically active substances that may be produced in irradiated products is discussed. (auth)

36979 RESISTANCE OF THE AZOTOBACTER CYST. M. D. Socolofsky and Orville Wyss (Univ. of Texas, Austin). J. Bacteriol., 84: 119-24(July 1962).

The radioresistance of cells of an encysting, butanol Azotobacter culture was compared with that of cells of a nonencysting, sucrose culture to investigate how the encystment process confers a survival advantage upon the cell. Azotobacter agilis (A. vinelandii strain 12837) was uv irradiated at a dose rate of 55 erg/mm^2/sec. Ionizing radiation was also applied from a ^{60}Co source at a rate of 1188 R/min. The results indicated that 90%-cyst-inactivation required twice as great a uv dosage as correspondingly treated vegetative cells. The acquisition of uv resistance during the encystment process was gradual and appeared to be related to the formation of exine and intine. A slow loss of uv resistance during germination was also noted. The cysts exhibited no marked resistance to heat, but were extremely resistant to γ radiation, sonic treatment, and desiccation. An even greater difference in radiosensitivity between encysted and vegetative Azotobacter cells was noted with γ than uv radiation. A single-hit exponential death curve resulted with both cysts and vegetative cells. About 6 kR inactivated 90% of the vegetative cells, while almost 40 kR were required for an equivalent lethal effect with the encysted cells. The effects of irradiation cells during different stages of encystment are also presented. Evidence is presented indicating that the cyst is not a bacterial endospore. The encystment process may confer a survival advantage upon the organism by coupling the low endogenous respiration rate with the ability to withstand desiccation. (BBB)

36980 EVIDENCE FOR IMMUNOLOGIC INJURY TO LEUKOCYTES EXPOSED TO IONIZING RADIATION. Reginald P. Pugh, William J. Harrington, Victoria K. Mayer, James Rothschild, Carolyn J. Graefe, and Phyllis M. Langsam (Washington Univ., St. Louis and Univ. of Miami, Fla.). J. Lab. Clin. Med., 64: 425-32(Sept. 1964).

One component of injury from ionizing radiation may be the formation of new cellular antigens which are in turn immunologically rejected by the host. Evidence is presented that seems consistent with this concept. Albino rats were immunized with bone marrow from either x irradiated or nonirradiated isologous donors. When subsequently challenged with radioactive phosphorus, the irradiated-marrow recipients developed significantly more severe granulocytopenia than those immunized with normal marrow cells. These observations closely parallel more extensive ones obtained previously with radiomimetic alkylating agents. If the antigenic changes reflect modifications of DNA, then a possible mechanism for some of the cumulative and lasting effects of injury from ionizing radiation is suggested. (auth)

36981 THYROID CANCER: COHORT ANALYSIS OF INCREASING INCIDENCE IN NEW YORK STATE, 1941-1962. Robert E. Carroll, William Haddon, Jr., Vincent H. Handy, and Edward E. Wieben, Sr. New York State Dept. of Health, Albany). J. Natl. Cancer Inst., 33: 277-81(Aug. 1964).

Thyroid cancer incidence rates based on cases reported to the New York State Cancer Registry have more than doubled from 1941 to 62. The increase has occurred only in persons under age 55. Cohorts born prior to 1900 have about the same incidence at each age. After 1910 the rate at each age approximately doubles for each successive decade of birth. Changes in reporting and diagnosis cannot account for the increase, which seems to reflect a true increase in the disease. The change in the cohort pattern about 1910 coincides with the onset of x ray therapy for thymic enlargement and strongly supports the hypothesis that irradiation in infancy and childhood is a significant causal factor in thyroid cancer. A method of cohort analysis allowing more precise determination of the year of change in cohort rates is described in the Appendix. (auth)

36982 STIMULATION OF ERYTHROPOIETIN PRODUCTION BY WHOLE-BODY IRRADIATION (SPLEEN SHIELDED). Abraham Gutnisky, Mary Lou Nohr, and Donald Van Dyke (Univ. of California, Berkeley and Consejo Nacional de Investigaciones Cientificas y Tecnicas, Argentina). J. Nucl. Med., 5: 595-605(Aug. 1964).

Increase in erythropoiesis in the spleen as a result of irradiating the remainder of the body was demonstrated. That the erythropoiesis in the shielded spleen can be abolished by hypertransfusion or administration of erythropoietin antibody and enhanced by administration of exogenous erythropoietin indicates that erythropoiesis in the shielded spleen is, like normal marrow, under erythropoietin control. Since erythropoietin production is apparently increased in the absence of any known stimulant (anemia, hypoxia, or increased cobaltous ion concentration), it is suggested that irradiation may be a stimulus to the release of increased amounts of erythropoietin into the circulation via a mechanism not yet understood. Results of the study indicate that increased erythropoiesis in the shielded spleen following irradiation results from a combination of doubling the erythropoietin production and increasing the sensitivity to erythropoietin. (auth)

36983 TREATMENT OF MEATS WITH IONISING RADIATIONS. XI. CHANGES IN THE TEXTURE OF MEAT.

A. J. Bailey and D. N. Rhodes (Low Temperature Research Station, Cambridge, Eng.). J. Sci. Food Agr., 15: 504-8 (July 1964).

The treatment of pork or beef with ionizing radiation resulted in a tenderization, as judged by a taste panel after cooking, detectable at a dose of 2-Mrads and marked at 4-Mrads. Irradiation after a partial cooking produced less effect. The solubility of the collagen in intact beef muscle was increased by irradiation, as was that of rat tail tendon immersed in meat juice or enclosed in meat tissue. Both collagens became less soluble when irradiated in saline. The solubilization of collagen was considered to be the result of an indirect action of radicals formed in water, prevented by the presence of the soluble constituents of the meat. These changes in collagen did not account for the whole of the effect of radiation on texture. (auth)

36984 A ROENTGENOGRAPHIC STUDY OF THE DEGRADATION OF COLLAGEN CAUSED BY HIGH DOSES OF γ-RADIATION. A. Blažej and L. Cebecauer. Kožařstvĭ, 12: 290-2(Oct. 1962). (In Slovak)

Samples of calfskin, cowhide, pigskin, and goatskin were exposed to 10^7 and 10^8 R of ^{60}Co γ radiation. The results were studied by wide angle x-ray diffraction and by electrophoresis. In moist samples, collagen was destroyed only after exposure to the 10^8 R dose of radiation. A mixture of fractions, which formed crystalline aggregates larger than 10^{-4} cm, was produced. A part of the fractions retained its triple spiral configuration even at this dose, while another part formed a heterogenous mass of polypeptides. The remainder (the fraction that was not water-extractable) formed a denatured collagen. When a small amount of water was present in the leather samples, the degradation changes were considerably less. (OID)

36985 PRESENT INFORMATION ON GENETICAL AND SOMATIC EFFECTS OF RADIATION. C. Biagini (Università, Rome). Minerva Nucl., 8: 203-7(July-Aug. 1964).

Biological effects of radiation on mammals and on human subjects are analyzed in dependence of various factors affecting them: total dose or cumulative dose, physical distribution of doses in tissues, time factor, age, and physiological conditions of the irradiated subject. The problem of the significance of small doses of radiation is discussed. The consequences of the exposure to various levels of doses are considered and the interpretation of the existing data is examined, on the basis of the quantitative characters of the dose-effect curves. Information on genetical effects of radiation is summarized, with reference to the risk represented by medical uses of radiation sources. Some data on somatic effects of radiation are briefly reported, mainly those dealing with researches on chromosomal aberrations and on some late effects of radiation (leukemia, cancer, shortening of life-span). The magnitude of the doses which may induce injurious effects on the developing embryo is also considered. A scale of levels of radiation doses is given, related to the corresponding biological responses. (auth)

36986 PROLIFERATION OF TRANSFERRED SPLEEN CELLS AFTER ANTIGENIC CHALLENGE. Martin J. Cohen and Edward P. Cohen (Univ. of Colorado, Denver). Nature, 203: 418-19(July 25, 1964).

A combined fluorescent antibody-autoradiographic method was used in mice to determine whether transferred antibody-forming cells divided after the injection of antigen. Results indicated that mitosis of donor antibody-producing cells occurred after antigen injection in the recipient as well as in the intact animals. The presence of label in cells producing antibody was direct evidence of DNA synthesis and donor cell division in the recipient x-irradiated mouse. (H.M.G.)

36987 EFFECT OF SULPHYDRYL REAGENTS ON THE FREQUENCY OF X-RAY-INDUCED AUTOSOMAL RECESSIVE LETHAL MUTATIONS IN DROSOPHILA MELANOGASTER. C. E. Purdom and Bryn A. Bridges (Medical Research Council, Harwell, Berks, Eng.). Nature, 203: 419(July 25, 1964).

The induction of autosomal recessive lethals in Drosophila melanogaster was studied by the brood analysis technique that tests germ cells irradiated at all stages of maturation. Prior to x-irradiation under anoxic conditions, the animals were injected with saline, saline plus N-ethylmaleimide, (NEM), or iodoacetamide (IAAm). A significantly higher mutation frequency was observed in the group treated with NEM compared to the saline-injected group, but not in the IAAm and saline injected groups. (H.M.G.)

36988 POTENTIATION OF VIRUS LEUKAEMOGENESIS IN C57BL MICE BY X-IRRADIATION OR URETHANE. Miriam Liberman, Nechama Haran-Ghera, and Henry S. Kaplan (Stanford Univ., Palo Alto, Calif.). Nature, 203: 420-2(July 25, 1964).

The effects of x-irradiation and or urethane or lymphoma development induced by RLV virus isolated from radioinduced leukemia of strain C57BL mice were studied in strain C57BL/Ka mice of various ages. Combined treatment with RLV and irradiation increased lymphoma incidence well above that resulting from either treatment alone, suggesting a synergistic action. From further experiments, it was concluded that x-irradiation and urethane potentiate the leukemogenic activity of RLV in mice of strain C57BL. However, the mechanism of potentiation was not established. (H.M.G.)

36989 HIGH RESISTANCE OF MONGOLIAN GERBILS TO IRRADIATION. M. C. Chang, Dorothy M. Hunt, and Charles Turbyfill (Worcester Foundation for Experimental Biology, Shrewsbury, Mass.). Nature, 203: 536-7(Aug. 1, 1964).

A high resistance of mongolian gerbils (Meriones unguiculatus) to radiocobalt irradiation was observed and the results are reported. It was found that unoperated animals were able to withstand 1000 R in repeated doses except for one group in which older animals were included and the interval between exposures was short. These factors may be attributed to their mortality. The mortality following irradiation at 1000 R was chiefly due to operation. The gerbils, however, were not able to withstand a dose of 1500 and 2000 R and all except one succumbed between 9 and 19 days after the exposure. On autopsy the intestines of all animals appeared hemorrhagic and the peritoneal fat displayed petechial hemorrhages in many instances. The pyloric region of the stomach was usually hemorrhagic but the stomach contained food in all cases. (P.C.H.)

36990 STUDIES ON THE EFFECT OF Co^{60}-GAMMA RADIATION ON LUPINUS TERMIS. S. Amer and H. A. Hakeem (National Research Centre, Cairo and Ein-Shams Univ., Cairo). Radiation Botany, 4: 95-100(June 1964).

Seeds of Lupinus termis were exposed to gamma rays resulting from ^{60}Co nearly 5 months prior to cultivation. The doses employed were 4, 7, 12, 16, 20, and 25 Kr respectively. The effects of radiation on the percentage of germination, plant survival, plant growth, flowering, and crop yield were studied for two successive years. No clear trend of germination or survival with dose was observed.

Statistical analysis showed that the applied doses of ^{60}Co gamma radiation had no significant effect on plant growth. No difference in the time of flowering of the irradiated plants as compared with the controls was observed; and the maximum flowering was reached at the same time as the control. From the treatments used, only the 12 Kr dose caused a significant increase in the crop yield in the second filial generation. (auth)

36991 THE EFFECT OF CENTRIFUGATION ON X-RAY-INDUCED CHROMOSOMAL ABERRATIONS IN MICROSPORES OF TRADESCANTIA PALUDOSA. Edward Yeargers (Emory Univ., Atlanta). Radiation Botany, 4: 101-6 (June 1964).

Microspores of Tradescantia paludosa were given 400 r of x rays at 50 r/min at 30°C. Microscope slides were made from anther squashes after varying periods of time and cells at metaphase were scored for two-hit chromosomal aberrations. Controls centrifuged up to 10,000 × g for 8 min, but not irradiated, showed no aberrations. When inflorescences were irradiated and centrifuged at low forces simultaneously no increase in the aberration yield (after 96 hr) was found. As centrifugal force was increased, however, the aberration yield increased non-monotonically. A second set of experiments was performed using 400 r at 50 r/min in air. Aberrations were scored after 3, 4, and 5 days. The day in which the maximum number of aberrations was recovered shifted from the fourth to the fifth when centrifugal force exceeded 5,000 × g. The data are interpreted as showing that two processes affect aberration frequency during centrifugation. One, best described by an exponential relationship, tends to increase the aberration yield while the second, best described as linear, tends to increase the yield of aberrations. (auth)

36992 A COMPARISON OF X-RAY- AND ULTRAVIOLET-INDUCED ABERRATIONS IN POLLEN TUBE CHROMOSOMES OF TRADESCANTIA. I. DOSE CURVE RESPONSES TO VARYING MOISTURE CONDITIONS. Paul C. Bailey (Alabama Coll., Montevallo). Radiation Botany, 4: 115-19(June 1964). (TID-19504)

The influence of moisture content on the number of x-ray- and u.v.-induced chromosome aberrations in the pollen tube chromosomes of Tradescantia paludosa was studied. The x ray doses used ranged from 50 r to 600 r, all administered at 100 r/min. The u.v. source was a germicidal lamp, and the incident doses used ranged from 1×10^5 ergs/cm^2 to 3.5×10^6 ergs/cm^2. Pollen was irradiated following exposure to three different moisture conditions. Results of the study indicate that the pollen tube chromosomes are more sensitive to x rays as the moisture content or stage of growth of the pollen is increased. Dose curves for both chromatid and isochromatid deletions are shown. The results of the u.v. experiments indicate that pollen which has been desiccated for 4 hr immediately before irradiation shows aberrations similar to those produced by x rays. Pollen which was irradiated after having been in a saturated moist chamber for 1 hr or after having been sown for 1 hr shows a different type of damage—one which causes a clumping or a shattering of the chromosomes. This damage was more pronounced as the moisture content was increased and as the dose was increased. (auth)

36993 A COMPARISON OF X-RAY- AND ULTRAVIOLET-INDUCED ABERRATIONS IN POLLEN TUBE CHROMOSOMES OF TRADESCANTIA. II. INFLUENCE OF PROTEIN SYNTHESIS INHIBITORS. Paul C. Bailey and Sheldon Wolff (Alabama Coll., Montevallo and Oak Ridge National Lab., Tenn.). Radiation Botany, 4: 121-5(June 1964).

Experiments were performed on pollen grains of Tradescantia paludosa in which either x-irradiated or ultraviolet-irradiated pollen was germinated on media containing a protein synthesis inhibitor. The inhibitor caused an increase in chromatid aberration yields in x irradiated but not in u.v.-treated pollen. This is consistent with previous findings that protein synthesis is necessary for the repair (rejoining) of x ray-induced breaks and that the rejoining mechanism is inhibited more effectively by u.v. than by x rays. (auth)

36994 QUANTITATIVE ANALYSIS OF RADIATION-INDUCED SECTORIAL DISCOLORATION OF THE FIRST LEAF OF CROTALARIA INTERMEDIA. J. Sybenga (Agricultural Univ., Wageningen, Netherlands and Brookhaven National Lab., Upton, N. Y.). Radiation Botany, 4: 127-39 (June 1964). (BNL-7608)

Ionizing radiations applied to seeds or young seedlings of Crotalaria intermedia induce dominant mutations that appear as discolored sectors in the first seedling leaves. The discoloration is caused mainly by structural abnormalities in the palisade layer. Their basis is shown to be most probably chromosomal aberrations of the two-break type (two-hit events). Quantitative evaluation of the results of a number of experiments gave information on processes involved in the induction of chromosome breaks and their expression as mutation. Dose-effect curves for x rays and γ rays were only slightly exponential, sometimes even linear. Yet clear dose-fractionation effects indicated two-hit events. The seeming contradiction is explained by assuming heterogeneity in sensitivity among the cells of the primordium, in addition to limitations in the number of exchange sites. The effect of moisture content on sensitivity to x rays showed a minimum sensitivity after equilibration of the seed at approximately 30 per cent relative humidity. After 24 hr of soaking a 25-fold increase in sensitivity was observed. The sensitivity increased as germination progressed over the entire range studied. Anoxia reduced the effect of x rays by approximately a factor of 2. No interactions between anoxia and moisture content could be demonstrated. Wetting of the seed under anaerobic conditions had no effect on x ray sensitivity of the re-dried seed. Sensitivity to neutrons was increased, however. Varietal differences in radiosensitivity were observed. (auth)

36995 INDUCED MUTATION AND PLEIOTROPY OF GENES RESPONSIBLE FOR QUANTITATIVE CHARACTERS IN RICE. Kan-ichi Sakai and Akio Suzuki (National Inst. of Genetics, Misima, Japan). Radiation Botany, 4: 141-51(June 1964).

About 160 X_4 lines of rice which were grown from the same number of plants selected at random from the X_3 population were compared with the same number of control lines. The x-irradiated and the control populations had been propagated since 1959 by one-plant-one-offspring method in order to free plants as much as possible from the effect of natural selection. Comparison was made for plant height, heading date, number of tillers or panicles, panicle length, plant weight, and grain yield. The genetic variation in the X_4 lines was without exception considerably increased in comparison with that in the control lines, while error variance remained approximately the same. Thus, the heritability values are found to be far higher in the X_4 lines than in the control lines. The mutation of polygenes responsible for the quantitative characters above mentioned was found to occur in most cases unidirectionally in minus direction. Heading date and plant height appeared to mutate in plus

direction, but the apparent increase in the mean values of these characters was understood as the result of minus mutations in vigor or growth of the plants. By comparing genetic correlations between the X_4 and the control lines, pleiotropic action of polygenes was investigated. The importance of genetic correlation between different quantitative characters due to pleiotropy of polygenes is discussed in relation to plant breeding. (auth)

36996 THE TUBERCULIN INTRADERMAL REACTION IN CANCER PATIENTS AND ITS BEHAVIOR IN RELATION TO THE EVOLUTION OF THE DISEASE AFTER RADIATION TREATMENT. G. Pelù and L. Ciampelli (Universita, Florence). Radiol. Med., 50: 546-9(June 1964). (In Italian)

The response to the tuberculin intradermal test in patients suffering from non-systemic malignant neoplasm was studied by following the course of the reaction before and after radiation treatment, and comparing it with the clinical evolution of the neoplasm. (auth)

36997 THE LATENT INTERVAL FOR THYROID CANCER FOLLOWING IRRADIATION. A. Raventos (Univ. of Pennsylvania, Philadelphia) and T. Winship. Radiology, 83: 501-8(Sept. 1964).

The time elapsed between the first radiation exposure of the thyroid and subsequent histologic diagnosis of thyroid cancer is collated for 528 cases in which the sequence of events has been reported. The frequency distribution of these latent intervals approximates a log-normal function. The mean log interval is 10.9 years. The latent intervals for females do not differ significantly from those for males. The latent intervals differ significantly in relation to the age at time of radiation exposure, being shortest for ages three to six years and longest for ages eleven to thirty years. The distribution of latent intervals within each irradiation-age group studied is approximately log-normal. Possible explanations for the age differences are discussed. (auth)

36998 COMPARATIVE CHANGES IN RADIOSENSITIVITY BETWEEN BONE MARROW AND A RAT TUMOR IRRADIATED UNDER ANOXIA. Frank V. Comas (Oak Ridge Inst. of Nuclear Studies, Tenn.). Radiology, 83: 528-33(Sept. 1964).

This study was undertaken to determine whether or not there was a differential effect of anoxia on the radiosensitivity of a rat tumor (Walker carcinosarcoma-256) and of a normal tissue (femoral bone marrow). The animals were implanted with tumor in both legs and given radiation while the vascular supply to the left lower leg was temporarily cut off. The duration of DNA synthesis depression was taken as the criterion for measuring radiation effect. It was found that anoxia protected the tumor by a factor of 1.6, whereas it protected the bone marrow to a greater extent, by a factor of 2.0. (auth)

36999 RADIATION GENETICS OF THE RHESUS MONKEY, MACACA MULATTA. II. THE EFFECTS OF X-IRRADIATION ON THE SPERMATOGENESIS OF THE MONKEY, MACACA MULATTA. C. C. Tan, S. Y. Chao, C. S. Chang, and T. T. Liu (Futan Univ., Shanghai). Sci. Sinica (Peking), 13: 1253-64(Aug. 1964).

The results of observations on the quantitative and morphological changes of the various types of cells in the testes of the monkey, Macaca mulatta, which were exposed to 200 R-units of x irradiation are presented. For the purpose of comparison, the testes were each separately taken out at different intervals, i.e.: 5, 10, 20, 30, 40, 50, and 60 days after irradiation. The radiosensitivity of the cells at different stages of spermatogenesis was found to be in close conformity with the similar experimental data obtained in the rodents as previously reported by others. The degree of radiosensitivity appears to be in inverse relation with the progress of maturation, that is, it is highest in the spermatogonial stage and becomes lowered gradually in the order of primary spermatocytes, secondary spermatocytes, and spermatids down to spermatozoa which prove to be least sensitive. On as early as the 5th day after irradiation, however, the counts of spermatids and spermatozoa also showed some sign of decrease in number as compared with the controls, indicating that they are likewise sensitive to some extent. Besides, the seminiferous tubules evidently underwent shrinkage, as a result of which the number of Sertoli cells per cross-section unit area appeared to increase correspondingly, though such cells rarely multiplied. That there exists such an apparent relation between the reduction in the number of germ cells on one hand and the shrinkage of seminiferous tubules with the corresponding increase in the number of Sertoli cells on the other, may be taken as a useful index of radiosensitivity. The data on the quantitative changes relative to the cells in different stages of spermatogenesis at various intervals after irradiation are suggestive also of a phenomenon of synchronization. Whether this was due to the direct lethal effect of x rays on the spermatogonial cells or to the inhibition of the mitotic division cannot be ascertained until the data on the effect of x rays upon the different types of spermatogonial cells (type A and type B) and on the exact stage of division at which nuclear aberrations occur are available. There exists, however, an apparent heterogeneity in radiosensitivity and in ability to recover between the different parts of the seminiferous tubules and among the cells in the different regions of the same lumen. The decrease in the total number of cells inclusive of spermatozoa reached a minimum on the 40th day after exposure to x irradiation, and the observations on the 50th and 60th day specimens showed that the number ceased to decrease and in fact tended to recover. It may suggest that the completion of a single cycle of spermatogenesis in the monkeys probably takes about 50 days. (auth)

37000 EFFECTS OF X-RAYS ON THE GROWTH, MATURATION AND FERTILITY IN RATS IRRADIATED AT SEVENTH DAY AFTER BIRTH. VI. OESTROUS CYCLE AND MATING BEHAVIOR IN FEMALES. J. Chu and W. C. Fu (Inst. of Experimental Biology, Academy of Science, Shanghai). Shih Yen Sheng Wu Hsueh Pao, 8: 285-300(Dec. 1963). (In Chinese)

Female baby rats were exposed to whole body x-irradiation with single doses ranging from 100 to 400 R to study their effect on the oestrus cycle. Daily smears were taken after the day of the vaginal opening throughout a period of six months. The smears were classified according to the four stages defined by the usual way. In the second series of experiments to examine the mating behavior of irradiated sterilized females, only higher dosages of 300 and 400 R were used, respectively. After the opening of the vagina, each treated female was then housed with a fertile normal male in a separate cage, and daily smears were also taken throughout the period under observation. The presence of spermatozoa was recorded. The observations made indicated that after sexual maturation normal oestrus cycle in irradiated animals could persist for a variable period according to the dosage of radiation. The duration of this regular period was shorter with higher doses and longer with lower doses. Thereafter, oestrus cycle be-

came irregular and smears taken from animals irradiated by lower doses (100 and 200 R) almost always showed prolonged vaginal cornification. In animals irradiated by higher doses (300 and 400 R), prolonged dioestrus happened in most cases. Since smears which indicated proestrus were very rare because of its short duration, the data were not sufficient for the analysis of radiation effect on this phase. However, the duration of proestrus in irradiated animals appeared more shortened as compared with that of control series. On the other hand, no significant change in the duration of the metoestrus phase was found among the experimental animals. Based on these experimental results, the relation between the alteration of oestrus cycle and the elimination of the germ cells and follicle organs from the ovaries in irradiated animals was discussed. In a second series of experiments, one out of eleven animals irradiated by 300 R and eight out of another thirteen animals irradiated by 400 R had completely lost their capacity for mating, in spite of the fact that some of them also experienced oestrus cycles almost normally for a considerable period. For the rest of the animals in these two series, individual difference in mating behavior existed after their maturation. In some animals irradiated by either 300 or 400 R, mating also took place very frequently at any time after prolonged or continuous vaginal cornification had set in. These results differed very much from those found in animals irradiated in adult. Therefore, it seems that the number of mating in mature rats grown from irradiated baby animals bears no direct relation to the normal degree of oestrus cycles which they had experienced. Few matings that had occurred in metoestrus and dioestrus were also observed. (auth)

37001 RESEARCH ON THE RADIOSENSITIVITY OF ANTIBODY FORMATION OF SPLEEN CELLS IN TRANSPLANTATION EXPERIMENTS. Hans-Stephan Stender, Dieter Strauch, Guenther Thuerigen, and Norbert Janssen (Universität, Marburg/Lahn, Ger. and Universität, Giessen, Ger.). Strahlentherapie, 124: 389-97(July 1964). (In German)

Splenic cells stimulated by an antigen and transplanted after two days to homologous animals, in which immunologic reaction was inhibited for some time by total body irradiation, produce antibodies in the receiver after the transplantation. The influence of pre-treatment and irradiation on the ability of the splenic cells to produce antibodies was investigated. If rats (donors) of which splenic cells are to be transplanted, were irradiated with 250 rads from a telecobalt source two days prior to the administration of a Brucella antigen, the antibody production is significantly retarded and decreased compared to control. Irradiation with 350 rads inhibits completely the antibody production. Antibody production is less inhibited by irradiation with 250 rads, if the lymphoreticular tissue of the animals is activated with pyrifer or zymosan prior to irradiation. Using this treatment prior to irradiation, the radiation damage to splenic tissue is decreased and the number of splenic cells which are stimulated by the antigen after irradiation, and which produce the antibodies, is increased. (auth)

37002 INVESTIGATION OF RADIOSENSITIVITY OF DESOXYRIBONUCLEIC ACID. II. LENGTH OF NUCLEOTIDE CHAINS AFTER IRRADIATION IN VITRO. Ulrich Hagen (Universität, Freiburg, i. B.). Strahlentherapie, 124: 428-37(July 1964). (In German)

Using viscosity measurements as well as the determination of sedimentation constants, the molecular weight of the deoxyribonucleic acid was determined after x-ray irradiation in aqueous solution. Irradiation of the solutions was done under three different conditions: irradiation and measurement during natural state of the molecule; irradiation of native DNA, followed by separation of the two nucleotide chains by careful denaturation and then measurement of the molecular weight; and denaturation of the DNA prior to irradiation. Comparing the different dose effect curves, the size of the native DNA-molecule as well as the length of the single nucleotide chain can be determined. It was found that numerous single breakages must be present in an irradiated DNA-molecule before the double chain breaks. Double chain breakage not only occurs if two single breakages are located opposite to each other, but also when up to 10 nucleotide pairs are located in-between. In this case numerous hydrogen bindings are broken up. Breakage of about 24 H-bindings also occurs with each single break. Denaturation of DNA measured after irradiation can be explained by this. (auth)

37003 INVESTIGATION OF CALCIUM METABOLISM IN THE EPI- AND METAPHYSIS AFTER LOCAL X IRRADIATION. VI. EFFECTS OF BELATED AND CROSSED DENERVATION ON THE GENERAL REACTION. Jaromir Kolár and Arnost Babicky (Technical Univ., Prague and Isotope Lab., Czechoslovak Academy of Sciences, Prague). Strahlentherapie, 124: 438-44(July 1964). (In German)

In previous experiments it was shown, that a localized radiation damage caused a generalized metabolic reaction in the entire skeleton and in teeth. A hypothesis concerning the importance of the nervous system in the introduction of such general reactions was confirmed by further experiments with crossed and belated denervation. Denervation of the injured leg can inhibit the appearance of the general reaction only up to a certain time. Using the crossed denervation (irradiation of one rear leg and denervation of the other leg) only the denerved leg is spared from the general reaction, in the remaining skeleton the reaction appears to its full extent. (auth)

37004 INVESTIGATIONS ON BIOLOGICAL RADIATION PROTECTION. LIV. CONTENT OF FREE AMINO ACIDS IN SPLENIC TISSUE OF MICE AFTER WHOLE-BODY IRRADIATION. Hanns Langendorff, Christian Streffer, and Hans-Joachim Melching (Universität, Freiburg, i. B.). Strahlentherapie, 124: 445-56(July 1964). (In German)

The content of free amino acids in spleen is decreased in white mice after total body irradiation. This result could be caused by changes in the cell membrane. The amino acid content was found to be increased 24 hrs after irradiation and remained high up to 10 days. The relative changes in glycine, α-alanine, glutamic acid, and asparaginic acid are small. Up to 24 hrs after irradiation the content of cysteine and glutathione was below normal, because these amino acids are decomposed oxydatively. Compared with the other amino acids, the increase in cystathionine is small. (auth)

37005 EFFECTS OF X-IRRADIATED DAUGHTERS ON EMBRYONAL DEVELOPMENT OF CHICKENS. Wolfgang W. Zoeller (Universitat, Bonn and Kernforschungsanlage, Julich, Ger.). Strahlentherapie, 124: 457-65(July 1964). (In German)

If only yolks of unbrooded eggs of the white Leghorn chicken were irradiated with 1500 to 5000 R, the normally occurring death rate at the 2nd to 3rd day of development was increased. The surviving embryos showed a distinct growth inhibition of the extraembryonal blood circulation.

Moreover, the embryos remain smaller than those of the control animals and their growth in tissue culture is retarded. Chickens which were brooded prior to hatching, were not able to hatch because of insufficient yolk resorption. The growth inhibition of the yolk vessels can be considerably normalized by injection of tryptophane, phenylalanine or nicotinic acid amide, but not by injection of glucose. The embryos showed no damage if the yolk was irradiated after the 3rd day of brooding. The described disturbances in development can be only of indirect nature, because the yolk was irradiated separately from the embryo. (auth)

37006 EFFECTS OF UV RADIATION OF DIFFERENT WAVELENGTH RANGES ON THE MORTALITY OF WHITE MICE DURING THEIR POST-EMBRYONAL DEVELOPMENT. Henryk Lach, Stanislawa Stoklosowa, and Jozef Surowiak (Jagiellonian Univ., Krakow and Padagogische Hochschule, Krakow). Strahlentherapie, 124: 466-76 (July 1964). (In German)

White mice of the inbred of an impure strain were treated by ultraviolet rays of two spectral areas: from 289 to 405 mμ and from 254 to 405 mμ, and an energy of 23,000, 36,200, and 55,000 erg/sec cm^2. The uv rays were applied daily in gradually intensified doses from 1 minute to 10 or 15, beginning on the second day of life till the eighth week, and in large initial doses at once of 15, 10 or 7 minutes from the 2nd day of life. In result in the first three groups, where adequate doses were used a reduction of the mortality of the specimens in relation to the control group of 1.5 to 4% was obtained. By the use of adequately intensified doses, the mortality rose from 15 to 100% already after ten days of exposure. From the data it results that in the application of the uv irradiation the point is the respective choice of the dose. Not the area but the dose decides about the final result of the irradiation. There attention will be paid also to the possibility of the occurrence of photorecovery processes beside the photochemical processes resulting from the animals' stay in light rooms after the uv irradiation. (auth)

37007 EFFECT OF RADIOACTIVE CALCIUM ON TESTIS, AUTORADIOGRAPHIC OBSERVATION. Hungsik Kwun (Chonnam Univ., Kwan-ju, Korea). Theses Chonnam Univ., 8: 253-9(1963). (In Korean)

Male adult albino rats were given 10 mC/100 g body weight $^{45}CaCl$ twice at 10 day intervals and stripping film techniques were used to assess the influence on estradiol and cortisone. Interstitial cells of rat testes were scarcely found in the normal autoradiogram. The fine silver grains due to radioactive calcium were found in supporting cells and scarcely in germ cells, but differentiation of the germ cells was considerably diminished. In the testis of the rats administered estradiol, dystrophy of the germ cells and peritubular fibrosis were apparent. Silver grains of ^{45}Ca markedly increased in interstitial substance and germinal epithelium, especially in supporting cells. The testis treated with cortisone showed marked dystrophy of the germinal epithelium and silver grains in the interstitial substance and germinal epithelium were packed. Estradiol and cortisone acted not only as depressors to the testicular tissue, but also as facilitators to the influence of radioactive calcium on the germinal epithelium of the rats. (auth)

37008 RADIOLOGICAL STUDIES OF THE BACTERIAL VIRUSES: A SYNOPSIS. James G. Van Dyke (New York Univ., New York). Trans. N. Y. Acad. Sci., 26: 947-53 (June 1964).

Results are reviewed from studies of the mechanisms involved in the inactivation of bacteriophage by radiation. The roles of DNA synthesis and replication and of messenger RNA in functional and replicative damage are considered. (C.H.)

37009 PROBLEMS AND POTENTIALITIES OF HEMATOPOIETIC TISSUE TRANSPLANTS. Seldon E. Bernstein (Jackson Lab., Bar Harbor, Maine). Trans. New Engl. Surg. Soc., 44: 76-83(1963).

Investigations with a hereditary macrocytic anemia of the house mouse attributable to the action of genes at a single genetic locus are considered. The gene series studied gives rise to a maturation arrest of erythropoietic tissue. When normal blood-forming tissue was placed into anemic mice, there was a gradual rise in the number of erythrocytes to almost normal values within 90 days. The number of histocompatibility gene differences that could be present without causing graft rejection was also studied. When only two histocompatibility differences were involved, no cures of any kind were experienced. Attempts were made to cross the major histocompatibility barrier by pretreating anemic mice with x rays in doses ranging from 200 to 950 R. Some success was obtained using isologous tissues and low levels of ionizing radiation, but not with massive doses of x rays. Implications for therapy of hematological diseases are discussed. (H.M.G.)

37010 HEMATOLOGIC AND PATHOMORPHOLOGIC CHANGES IN POULTRY CAUSED BY LETHAL DOSES OF RADIOACTIVE PHOSPHORUS. B. Dukic, J. Gligorijevic, and C. Rusov (Inst. for the Application of Nuclear Energy in Agriculture, Veterinary Medicine, and Forestry, Belgrade). Vet. Glasnik, 18: 427-33(1964).

Intramuscular administration of 4.5 or 9 mC/Kg of $Na_2HP^{32}O_4$ was given White Rock hens. The lower dose was lethal within 15 days of a single administration, but the doubling of this dose only mildly accelerated appearance of symptoms. The cause of the disease was quite reminiscent of acute radiation disease in other animals. (auth)

37011 THE POSSIBILITY OF AN INDIRECT EFFECT OF IONIZING RADIATION IN LIPID SOLUTIONS (RADIOLYSIS OF β-CAROTENE IN OLEIC ACID). Yu. B. Kudryashov, Z. Baltbarzdys, and Le-dak L'eu (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 156: 191-3(May-June 1964). (In Russian)

To clarify the question of whether lipids are involved in the indirect effects of irradiation on the living organism, beta-carotene in oleic acid solution was oxidized by irradiation. In control experiments, the radiolysis of beta-carotene in crystalline form and in solution in petroleum ether and in butanol was studied. Both x and gamma irradiation were used. Irradiation of crystalline beta-carotene to as high as 10^4 kR changed only 11 per cent of the molecules. In solution, beta-carotene was more radiation-sensitive, and was several times more sensitive to gamma irradiation in oleic acid solution than in butanol or petroleum ether. The dependence was linear for oleic acid solutions but not for the other two. The appearance of intermediate active products in the radiolysis of oleic acid solutions was indicated by the increase in radiation sensitivity of beta-carotene in oleic acid solution with decreasing irradiation rate. Such a variation was not shown in butanol or petroleum ether solutions. The formation of intermediates was further indicated by the great stability to irradiation of frozen oleic acid solutions of beta-carotene, in which such products would diffuse very slowly. For concentrations of 10 to 20 μg/ml, the degree of ra-

diolysis did not depend on the concentration. This is explained by the fact that in different volumes, for the same radiation dose, a constant amount of active intermediate products is formed in the oleic acid solution, which is sufficient for the reaction with the beta-carotene. In very dilute solutions, the degree of radiolysis is less since part of the active intermediates recombine. (TTT)

37012 MORTALITY IN RAT EMBRYOS (F_1) AFTER IRRADIATION OF PARENTAL GAMETES (P) AT DIFFERENT PERIODS OF THEIR ONTOGENY WITH SMALL DOSES OF X RAYS. B. A. Pozhidaev (Inst. of Experimental Medicine, Medical Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 156: 194-7(May-June, 1964). (In Russian)

White Wistar rats, both male and female, were x irradiated (50 R) as 10- to 19-day embryos (by irradiation of the parent) and at 7 to 45 days after birth. The irradiated males were mated with normal females and vice versa, and the development of the embryos from these matings was observed along with the corpora lutea. The mortality rate of the embryos from the irradiated females was high, and depended on the state of oögenesis and the age of the female at the time of the irradiation. Implantations decreased irregularly from 94% for those irradiated as 10-day embryos to 80% for those irradiated at 0 to 14 days after birth, and then increased to 85% in those irradiated as adults. The rate for controls was 89%. The rate of embryos dying after implantation increased from 24% in the females irradiated as 10-day embryos to 60% in those irradiated at 45 days after birth, but dropped to 9% in those irradiated as adults, the same value as for the controls. Embryos from males irradiated as 10-day embryos were 84% implanted. The number dropped to 70% in those irradiated on the day of birth but increased again to normal (89%) in those irradiated at 45 days age. The numbers dying after implantation dropped from 16% in the embryos of the 10-day-embryo irradiated males to 5% for those irradiated as 19-day embryos, and increased irregularly to 16% for those irradiated at 45 days age and to 21% for those irradiated as adults, compared to 9% for the controls. (TTT)

37013 THE RESPONSE OF LOOSE CONNECTIVE TISSUE TO THE ACTION OF ULTRAVIOLET RADIATION AND COLD. Yu. N. Solovev and D. M. Demina. Gigiena i Sanit., No. 7, 20-4(July 1964). (In Russian)

Data are presented on the changes developing in subcutaneous loose connective tissue of rats under the effect of cold, and ultraviolet radiations of various wave lengths, as well as under the combined action of the two factors. The ultraviolet light of long-wave spectrum, when used in suberythema doses, was found to have a stimulating effect on the cellular content of loose connective tissue, especially on young fibroblasts and histocytes. The cold, producing a stress-effect, depressed the loose connective tissue. The radiations of a PRK-4 lamp emitting also short-wave rays tended to depress the connective tissue. The combined application of cold and long-wave ultraviolet radiations from the EUV-15 lamp brought about summation of the action, the cold effect being subdued. (auth)

37014 URONEPHROSIS, AN ADDITIONAL LATE INJURY AFTER PYELOGRAPHY WITH THOROTRAST, PRODUCED BY DEPOSITION OF THORIUM DIOXIDE AT THE URETERAL OUTLET. R. Weyeneth (Universität, Geneva). Z. Urol., 55: 441-57(Aug. 1962). (In German)

Late injuries from Thorotrast, where the result was stenosis of the ureteral outlet, were described for three patients. In a 58-yr-old woman who was injected with Thorotrast ~20 yr previously, occlusion of the collecting tubules resulted from deposition of large amounts of the contrast material in the lower poles of the kidneys and ureteral outlets, and uronephrosis resulted. Because of the extensive changes in the kidney pelvis and upper portions of the urinary tubes, nephrectomy became necessary. In spite of the extensive vascular changes there was no increase in blood pressure. In a 49-yr-old woman who had received Thorotrast for pyelography 24 yr previously, hydronephrosis was caused by Thorotrast deposition in the ureteral outlet. In addition to the emptying defect, a Goldblatt syndrome (hypertension) resulted, probably caused by the renal arterial changes. At operation the renal arteries were found to be embedded in a stony, fibrotic mass. After nephrectomy the blood pressure dropped to normal. In a 72-yr-old man who suffered from prostatic carcinoma, for which routine urography was carried out, Thorotrast deposition was observed in the right kidney area. This was most pronounced of all at the ureteral outlet, and there was no apparent renal elimination of the Thorotrast after a 6 hr period of observation. (BBB)

37015 THE RECTOSIGMOID AFTER IRRADIATION OF GYNECOLOGIC CARCINOMA. Ladislav Brueckner, J. Mosler, J. Cerny, F. Beska, and O. Rek (Oncological Inst., Paskov, Czechoslovakia). Zentr. Gynaekol., 84: 1977-85(Dec. 22, 1962). (In German)

Symptoms of radiation injury were observed in 31 patients who had received from 6000 to 16000 R of x radiation (mostly 8000 to 10000 R) and from less than 5000 to more than 6000 mg-hr of Ra therapy (mostly 5000 to 6000 mg-hr). The symptoms appeared at from four months to over three yr after this therapy, with most occurring after one yr. The pathological-anatomical picture showed characteristic symptoms of erythema, angiectasis, mucous formation, ulceration, strictures and fibrosis, and perforation. Rectoscopy showed hyperemic mucosa, frequently with mucous secretion, and some areas of fibrosis. Generally, the intestinal lumen was narrowed, often by fibrosis of the submucosa (string sign). The intestine was edematous, with numerous infoldings of the mucosa caused by thickening of the mucosa and submucosa, with formation of pseudopolyps. The general contours were extremely variable. The haustrations were altered, with adhesions and strictures. The frequency and severity of intestinal injuries decrease with improvement of the radiation technique and dosimetry, supervision of diet, and administration of vitamins. Conservative treatment may include resection or colostomy. The unequal latency periods associated with appearance of late intestinal radiation injury in treated women requires close observation and the ability to distinguish it from recurrent tumors. (BBB)

37016 ON SOME PECULIARITIES OF DIFFERENTIATING POSITIVE CONDITIONED STIMULI WITH DIFFERENT REINFORCEMENTS AND THE INTERACTION OF HETEROGENEOUS CONDITIONED REFLEXES IN MAN AFTER CHRONIC IRRADIATION LESIONS. V. N. Zvorykin (Kirov Military Medical Academy, Leningrad). Zh. Vysshei Nervnoi Deyatel'nosti im. I. P. Pavlova, 13: No. 1, 27-33(1963). (In Russian)

A study was made of conditioned eyelid reflexes and motor reflexes with verbal reinforcement of healthy subjects and persons who had had chronic contact with ionizing irradiation. It was found that in cases of chronic irradiation difficulty was encountered not only in the formation of

differentiation to non-reinforced stimuli but also in differentiating positive conditioned stimuli connected with different reflexes. In subjects with irradiation lesions, generalization of conditioned reflexes was expressed to a greater extent than in healthy subjects, and their specialization took more time and was more difficult. During the interaction of heterogeneous conditioned reflexes, their reciprocal inhibition was manifested to a greater extent. The main cause of such peculiarities of conditioned activity under irradiation was the weakening of conditioned, active inhibition, a more pronounced irradiation of nervous processes and their insufficient concentration, which leads to a deterioration of the analytical and synthetic activity of the cerebral cortex and to complaints of a reduced fitness for work. (auth)

37017 ACUTE WHOLE BODY RADIATION INJURY: PATHOGENESIS, PRE- AND POSTRADIATION PROTECTION. Victor P. Bond, Eugene P. Cronkite, and Robert A. Conard. p.203-37 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964. (BNL-6683)

Mechanisms involved in radiation injury following whole-body exposure are discussed. It is postulated that the primary interaction between radiation and tissue may involve either direct effects on biological molecules or indirect effects on such molecules mediated through radicals produced by interaction of the radiation with water and other chemical substances in the tissue. Possible mechanisms discussed include enzyme inhibition, activated radicals, alterations in cell membrane permeability, generalized protein denaturation, inhibition of mitosis, chromosome changes, production and circulation of toxins, adrenal cortical insufficiency, and pancytopenia and its sequelae, such as infections and anemia. Preirradiation and postirradiation factors that may modify the response to whole-body irradiation are reviewed. Postirradiation factors that increase the survival rate discussed include the restoration of damaged hematopoietic tissues, stimulation of myelopoiesis and erythropoiesis, and modification of the histological and clinical picture by substitution of red cells, white cells, or blood platelets, with or without the use of antibiotics. (200 references) (C.H.)

37018 OSTATOCHNYEYAVLENIYA OSTROI LUCHEVOI BOLEZNI. (Late Effects of Acute Radiation Sickness). E. N. Antipenko. Moscow, Publishing House on Medical Literature, 1963. 156p.

Physiological and clinical findings on persons in Nagasaki and Hiroshima for some years after World War II are discussed. The late results of irradiation experiments on animals, together with discussions of their reactions, and of neuro-endocrine damage, are presented. A bibliography of some 400 publications is included. (IIC-MG)

37019 EFFECTS OF IONIZING RADIATION ON THE NERVOUS SYSTEM. A. V. Lebedinskii and Z. N. Nakhil'nitskaya. New York, Elsevier Publishing Company, 1963. 216p. $12.50.

Results are summarized from a number of recent studies on the effects of ionizing radiation on the nervous system. Five hundred references and a subject index are included. This book was abstracted from the original Russian language and appeared in NSA 16: 8629. (C.H.)

37020 EINWIRKUNGEN VON IONISATIONSSTRAHLUNG AUF DEN METABOLISMUS VON SERUMEIWEISSTOFFEN BEI KANINCHEN. (Influence of Ionizing Radiation on the Metabolism of Serum Proteins in Rabbits). Stefan Paulov. Bratislava, Vydavatel'stvo Slovenskej Akademie Vied, 1961. 53p.

Changes observed in serum protein metabolism in rabbits exposed to ^{60}Co are reported. Uptake studies of ^{35}S-labeled-methionine and ^{131}I-labeled-proteins by albumins and globulins in irradiated rabbits are also presented. (H.M.G.)

Radiation Effects Therapy and Countermeasures

37021 PROGNOSIS OF THE MAGNITUDE OF PERIPHERAL BLOOD CHANGES DUE TO THE GREAT LOSS OF BLOOD DURING ACUTE RADIATION SICKNESS. D. Zografov. Compt. Rend. Acad. Bulgare Sci., 17: 303-6(1964). (In Russian)

37022 REACTION OF BIOGENIC AMINES IN THE MECHANISM OF HISTAMINE PROTECTION AGAINST IONIZING RADIATION. S. Ya. Rapoport, E. I. Krichevskaya, and S. R. Zubkova (Inst. of Biological Physics, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 155: 1198-1200(Apr. 11, 1964). (In Russian)

The effects of catecholamine and serotonin on the radioprotective effects of histamine were studied under conditions in which (1) the sympathetic nervous system was blocked by ergotamine, (2) the catecholamine and serotonin in the organism were depleted by repeated treatment with reserpine, and (3) in the presence of serotonin antagonistic diethylamine lysergic acid. Results on white rats irradiated with a single 600 R dose at 45 R/min showed that serotonin alone does not influence the protective effects of histamine, catecholamine depletion and ergotamine blocking inhibit the protective effects. (R.V.J.)

37023 THE ROLE OF HISTAMINE AND SEROTONIN IN RADIATION INDUCED VARIATIONS OF EXCITABILITY OF THE VAGUS CENTER. M. M. Gromakovskaya (Inst. of Biological Physics, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 156: 187-90(May-June, 1964). (In Russian)

The effect of histamine and serotonin on the excitability of the vagus nerve center was studied in normal and x-irradiated (800 R) white rats weighing 120 to 150 g. The excitability was determined by observing the change in the rhythm of the heart contractions with electrocardiograms. Intraperitoneal injection of 1 or of 35 mg of histamine decreased the excitability of the vagus nerve center. Results were similar with 5 mg of polymyxin per kilogram, which liberates histamine, the excitability being sharply decreased 30 min after the first injection of polymyxin. The decrease in excitability with a dose of 50 μg of serotonin was similar to that observed in x irradiation or histamine injection. That the change in the vagus excitability on intraperitoneal administration of histamine or serotonin is a reflex action and is related to the stimulation of the afferent nerves is indicated by the weakening of the reaction of the parasympathetic nervous system in response to the intraperitoneal injection of these substances when the abdominal organs were locally anesthetized by injections of oil solutions of anesthetics. Suboccipital administration of serotonin before irradiation (50 μg) prevented the appearance of the radio-induced changes in the vagus. Apparently this results in excitation of the parasympathetic centers, ensuring conditions under which damage to the function of the vagus center cannot occur.

Suboccipital administration of histamine (100 μg) did not cause such action. (TTT)

37024 REDUCTION IN RADIATION LETHALITY BY CHEMICAL MIXTURE AND BONE MARROW IN MICE. J. A. Gantz and R. I. H. Wang (Army Medical Research Lab., Fort Knox, Ky.). J. Nucl. Med., 5: 606-12(Aug. 1964).

Using a mixture of three radioprotective chemicals (serotonin, AET, and MEA), the $LD_{50/30\text{-day}}$ exposure value was increased from 680 to 1500 R x radiation given to female C_3H mice. Combining this mixture pre-radiation with isologous marrow post-radiation, 91 per-cent 30-day survival at 1700 R and 52 per-cent 30-day survival at 2000 R x radiation was obtained. Seven deaths occurred within 30 minutes of injection of chemicals to 212 animals (3.3 per cent). One additional death was attributed to air embolis at the time of injection. All other deaths were considered radiation induced. It is suggested that effective protections with reduced toxicity is attained through synergistic chemical action, plus the additive action of marrow. The mechanisms remain unknown. (auth)

37025 TREATMENT OF UNAVOIDABLE COMPLICATIONS RESULTING FROM X-RAY THERAPY. G. Barth and W. Kern (Justus Liebig Universität, Giessen, Ger.). Radiologe, 2: 290-300(Aug. 1962). (In German)

Parameters affecting severity of radiation injury and method of treatment are identified. Various types of radiation injuries for which treatments are discussed are: skin, bone, lung, heart, intestine, kidney, and nervous system.

37026 EXPERIMENTS ON THERAPY OF LETHAL RADIATION INJURY OF WHITE MOUSE USING FOLIC ACID. I. EXPIRATION ORDER AND BODY-WEIGHT DEVELOPMENT OF HOMOZYGOUS AND HETEROZYGOUS FEMALE WHITE MICE. Herbert Graebner and Gunther Barth (Universität, Giessen, Ger.). Strahlentherapie, 124: 420-7(July 1964). (In German)

The influence of different dosages of folic acid after lethal total body irradiation on the death rate as well as the single weight developments in female white mice is reported. Using the different survival numbers at the 30th day, an optimum effect of the folic acid dosage is determined. Slightly better results are probably obtained for optimum folic acid dosage by keeping the animals single instead of in colonies. The single weights of the animals kept in colonies develop more homogeneously but do not exceed the initial weight. Heterozygote female mice show a slightly worse behavior. The possible mechanism of the folic acid is discussed briefly. (auth)

37027 PROPHYLAXIS AND THERAPY OF THE GENERAL REACTION TO RADIATION. H. Braband (Strahlenabteilung des Staedtisches Auguste-Viktoria-Krankenhauses, Berlin). Therap. Gegenwart, 102: 439-44(Apr. 1963). (In German)

Etiology, symptomology, prophylaxis, and therapy of the radiation reaction are discussed. Although radiation response arises from a complex and poorly-defined etiology, there is a direct relation to cellular changes. Since symptology is variable, nonspecific therapy is required. It is concluded that the best prophylaxis against radiation reaction following therapy or diagnosis is choice of an optimal radiation procedure. (H.M.G.)

37028 4-PYRAZOLIDINETHIOLS AND 4-PIPERIDAZINETHIOLS AS POTENTIAL ANTIRADIATION AGENTS. Milton Joseph Kornet. Thesis, Urbana, Ill., Univ. of Illinois, 1963. 122p.

Methods were developed for the synthesis of 4-pyrazolidinethiols and 4-piperidazinethiols. These mercaptoheterocycles are related to β-mercaptoethylamines and were prepared as potential radiation protective agents. The 4-pyrazolidinethiols were obtained by treating 3-chloropropylene sulfide with 1,2-disubstituted hydrazines in ether at room temperature. By this method, 1,2-dimethyl-, 1,2-diethyl-, 1,2-di-n-propyl-, 1,2-diisopropyl-, and 1,2-diisobutyl-4-pyrazolidinethiols were prepared in yields of 12–32%. Evidence to support proposed structures is presented. Epichlorohydrin underwent reaction with 1,2-disubstituted hydrazines analogously and afforded 1,2-disubstituted-4-pyrazolidinols. A mechanism for the reaction of 1,2-disubstituted hydrazines with 3-chloropropylene sulfide and epichlorohydrin is proposed. The free radical addition of thioacetic acid to 1,2-dicarbethoxy-1,2,3,6-tetrahydropyridazines gave high yields of 1,2-dicarbethoxy-4-thioacetoxypiperidazines, which served as key intermediates in the preparation of 4-piperidazinethiols. The thioacetoxy esters were modified as follows: (1) partial hydrolysis with one normal ethanolic hydrogen chloride to form 1,2-dicarbethoxy-4-piperidazinethiols; (2) complete hydrolysis with concentrated hydrochloric acid and glacial acetic acid to form 4-piperidazinethiols; (3) reduction by lithium aluminum hydride to form 1,2-dimethyl-4-piperidazinethiols. The infrared spectra of the 4-pyrazolidinethiols and 4-piperidazinethiols described exhibited a shift of the SH absorption frequency to lower wave numbers. Hydrogen bonding is advanced as the explanation for this shift. (A.G.W.)

Radiation Hazards and Protection

Refer also to abstract 37166.

37029 (A/CONF.28/P/812) EVALUATION OF DIFFERENTIAL NEUTRON DOSE DISTRIBUTION IN HUMAN PHANTOM USING $S^{32}(n,p)P^{32}$ REACTION IN HAIR. K. A. Mahmoud, A. N. Hanna, and E. A. Amin (United Arab Republic. Atomic Energy Establishment, Inshas, Egypt). May 1964. 8p.

In certain reactor accidents, human subjects are sometimes exposed to neutron beams which deliver unknown neutron dose to different human organs. The $^{32}S(n,p)^{32}P$ reaction due to neutrons of energy greater than 2 Mev was used as basis for neutron dose measurements. The neutron source was one of the horizontal neutron beams of the U.A.R. water-water cooled reactor and the sulfur present in human hair (30 to 50% dry weight) was the target material for neutron detection. Samples of human hair were placed at specific points of standard man phantom, which represent active bone marrow and gonads. The bone marrow was represented by the Ribs 1 to 4, 5 to 8, 9 to 12, Cranium and mandible Scapulae, humeral heads and clavicles–Sternum–Sacrum–Os Coxae–Femoral head and neck–Cervical Vertebrae–Thoracic Vertebrae 1 to 4, 5 to 8, 9 to 12 and Lumbar Vertebrae. The gonads were represented by left and right ovaries for female, and scrotum for male. The standard man was designed and constructed locally from a real human skeleton, filled with sherezine wax. Lungs were assembled in the form of two plastic bags filled with wet sawdust while intestines were replaced by strips of rubber foam soaked in paraffin. Samples of the same hair were also placed at certain points on the top of the phantom skull. The irradiation time and the positioning of the phantom in front of the neutron beam were chosen in a way to represent typical conditions of irradiation of

occupational workers in case of accidents or negligence of protectional signs when neutron horizontal beams are left open during reactor operation. The sulfur and phosphorus content of these hair samples inserted in the phantom, were assumed to represent the case in vivo. The experimental dose and dose rate data received by bone marrow, gonads, and hair of the skull were used for derivation of certain parameters correlating the dose or dose rate received by the skull hair to that received by gonads and bone marrow for different irradiation conditioning and for different phantom positions. These parameters were tabulated in a certain form which could facilitate the assessment of gonad or bone marrow dose received by man after accidental neutron exposure. (auth)

37030 (AD-600228) SCREENING OF POTENTIAL RADIOPROTECTIVE COMPOUNDS IN MICE. Annual Progress Report, March 15, 1963–February 15, 1964. Geoffrey Woodard (Woodard Research Corp., Herndon, Va.). Contract DA-49-193-MD-2405. 9p.

A total of 701 coded compounds were screened for their potential radioprotective potency in mice. An approximate maximum tolerated dose of each coded test compound was determined by administering the compound intraperitoneally in graded doses to groups of mice and these mice observed for pharmacologic and toxicologic signs. Survivors at seven days were subjected to gross necropsy, also. The test compound at this dose was then administered intraperitoneally to groups of six mice. At an interval when the compound was estimated to be most pharmacologically active, these mice were exposed to radiation from a Maxitron 300 x ray unit at a dose which was calculated to be the LD 100/30 in similar groups of untreated animals. Untreated animals were exposed to this dose of radiation at the same time thereby serving as controls. The estimated protection offered by administration of the test compound was then determined, as compared with control values, and tabulated. (auth)

37031 (AD-600229) TESTING OF ANTIRADIATION AGENTS IN MONKEYS, AS AMENDED. Annual Progress Report, July 1, 1963–May 1, 1964. Geoffrey Woodard (Woodard Research Corp., Herndon, Va.). Contract DA-49-193-MD-2458. 6p.

Mercaptoethylamine and three coded compounds which have been shown to be protective against ionizing radiation were studied with respect to the evaluation of their safety when administered to rhesus monkeys. Various parameters such as body weight gain, hemograms, blood and urine analyses, and histopathological observations were employed. A teratogenic evaluation of mercaptoethylamine in rats and a blood picture study in splenectonized rabbits are described. (auth)

37032 GENETICALLY SIGNIFICANT RADIATION DOSES IN DIAGNOSTIC RADIOLOGY. Erling Hammer-Jacobsen. Acta Radiol., Suppl. 222, 1-277(1963).

The genetically significant annual radiation dose per inhabitant from the application of diagnostic radiology in Denmark was calculated on the basis of material which as far as possible shall be representative of the whole country. A brief survey of the most important works published in the available literature is reported. Investigations include the following subjects: calculation of the total annual number of roentgen examinations, calculation of the distribution of the roentgen examinations on types of examinations and sex and age groups, measurement of gonad-doses in roentgen examinations, calculation of the genetically significant dose, discussion of the results obtained, and conclusions with the object of deciding whether the genetically significant dose is of such an order of magnitude that routine application of dose-reducing methods should be recommended, without impairment of the great value to the patients of the diagnostic procedures. (auth)

37033 FALLOUT EFFECTS. Irwin Pronin (City Coll. of New York). Baskerville Chem. J. City Coll. N. Y., 12: 6-14(1963).

Various aspects of the problems created by radioactive debris from nuclear weapons are considered. The disagreement among scientists over assessment of biological effects of exposure to the very low levels of radiation from fallout is discussed. Factors cited that have a major impact on the appraisal of radiation hazards from fallout include: nonuniformity of fallout within an isodose area; shielding factors; conversion of these variables into terms of absorption of energy from varying external sources over a period of time at critical areas within the human body; evaluation of these different energy absorptions in terms of different functional responses; and the variables of internal emitters as well as direct surface contamination. Some of the accepted facts and assumptions regarding fallout are also discussed. The question of a threshold level for life-shortening and carcinogenesis from internal radionuclide deposition is examined. Concentrations of nuclides (especially ^{90}Sr) in tissues of humans of various ages are reviewed and theoretical problems in extrapolating present data for projection to future human ^{90}Sr levels are discussed. Using published data and the fact that the rate of fallout decreases by a factor of four or five over the first two years and by a factor of two each year thereafter, estimates of ^{90}Sr radiation dose in bone (mr/yr) from a hypothetical 3000-Mt thermonuclear war giving 300 or 60 MC effective radiation are tabulated. The data are then used to derive an estimate of the possible somatic and genetic injuries to man resulting from worldwide fallout after such a war. An estimate is also given for the total number of gross physical or mental defects for future generations in the United States (without allowance for future population increases) resulting from all tests through 1961, namely 1000 from fallout and 2000 from ^{14}C. (TCO)

37034 THE EHRLICH ASCITES CARCINOMA AS A TOOL FOR THE RAPID EVALUATION OF THE EFFICACY OF RADIOPROTECTIVE COMPOUNDS AT THE CELLULAR LEVEL. J. F. Scaife (Dept. of National Defence, Ottawa). Can. J. Biochem., 42: 1307-16(Sept. 1964).

A simple, rapid quantitative method for biologically evaluating radioprotective compounds at the cellular level has been developed by means of Ehrlich mouse ascites tumor cells. The cells were irradiated in vitro and subsequently grown in vivo and the radioprotective compound was evaluated by its ability to prevent mitotic arrest and loss of proliferative capacity in the cells. Results statistically significant at the 1% level were available in 48 hours when groups of 15 mice per sample were compared. L-Cysteine was found to be a better protector than 2-aminoethylisothiouronium bromide hydrobomide or 2-mercaptoethylamine and also increased the protection of cells irradiated under anaerobic conditions. (auth)

37035 SOME TASKS AND PROBLEMS IN SPACE RADIOBIOLOGY. P. P. Saksonov, V. V. Antipov, and N. N. Dobrov. Federation Proc., Trans. Suppl., 23: T789-92 (July-Aug. 1964). Translated from Vestn. Akad. Med. Nauk SSSR, 18: No. 8, p.13(1963).

Problems arising from cosmic irradiation during space flight are discussed, and radiobiological data acquired

from Soviet space probes are reviewed. General clinical observations and special examinations of peripheral blood, bone marrow, urine, and state of natural immunity in mammals that had flown in Soviet satellites failed to reveal any pathologic signs of ionizing radiation effects. Negative effects of flight factors were absent in two generations of dogs that had been in space. It was determined that cytological damage in the bone marrow of mice following space flight were producible by vibration and acceleration as well as by ionizing radiation. Results of biological experiments are in agreement with data for the cosmic radiation dose yielded by various physical dosimeters. Hence, the Soviets conclude that there is no radiation risk in manned flight of short duration in an orbit below the radiation belt, providing solar flares are absent and adequate protection present. The difficulty encountered in establishing maximum permissible doses for space flights is attributed to the lack of sufficient data on the effects of various flight factors on the course of radiation reaction and on the reaction of the irradiated organism to the effects of such factors. Radioprotective drugs are reviewed, and criteria for pharmaceuticals intended as individual means of protection for crew members against harmful effects of cosmic radiation are presented. Radiation doses received during space flight by two cosmonauts are given. (H.M.G.)

37036 CONTAMINATION PROBLEMS ASSOCIATED WITH THE ADMINISTRATION OF MASSIVE DOSES OF SULFUR-35 TO PATIENTS. Joseph M. Brown, Jr., John R. Howley, Yvonne McIntosh, Donald Driver, and Mardalee B. Dickinson (National Inst. of Health, Bethesda, Md.). Health Phys., 10: 557-61(Aug. 1964).

Sulfur-35 as H_2SO_4 in HCl solution has been used by the National Institutes of Health in the treatment of chondrosarcoma. Therapy doses have ranged from 295 mc to 488 mc with the total amount of ^{35}S received by any one patient being 997 mc. Owing to the rapid excretion of ^{35}S in all body fluids, the problems of general radioactive contamination of the hospital are many, accentuated by the relative long half-life (87 days). The safety techniques developed for patient-care personnel are presented and contamination monitoring techniques and results are reported for two of the patients. (auth)

37037 STRATOSPHERIC RADIATION HAZARD FROM LARGE SOLAR FLARES: SOME PROPOSALS. I. J. Wilson (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). J. Brit. Interplanet. Soc., 19: 446-7 (July-Aug. 1964).

A proposal procedure is presented for monitoring stratospheric radiation from large solar flares. The procedure employs rockets, launcher, and neutron monitor based at the South Uist rocket range. (C.H.)

37038 THE MEDICAL USE OF RADIOISOTOPES AND THE CONTROL OF THEIR HAZARDS. R. Langmann (Gesundheitsamt, Muelheim, Ger.). Oeffentl. Gesundheitsdienst, 25: 270-5(May–June 1963). (In German)

Uses of radioisotopes in diagnosis and therapy are discussed. It is pointed out that the dangers of radiation exposure are much greater when radioisotopes are used for therapy than when they are used for diagnosis. Precautionary measures for medical use of radioisotopes are indicated. (H.M.G.)

37039 THE DANGERS OF RADIOSCOPIC EXAMINATIONS. Prophylaxie Sanit. Morale, 33: 258-9(Dec. 1961). (In French)

The use of radioscopic examinations should be accompanied by informing the subject of the danger involved and of his right to refuse examination. Routine use of radioscopic examinations exposes one to the dangers of abusive irradiation; 50% of radiodiagnostic examinations in France are practiced in series and carried out incorrectly; radioscopy is the most dangerous of these methods and should be condemned. It is less precise than radiography, the causes of errors are numerous, and it detects only 3 cases of illness per 1000, dangerously irradiating the other 997. Radiophotography was recently developed so that the dose of x rays used is negligible; it is thus one of the best tools for preventive medicine, and may be applied to detection of pulmonary diseases and congenital and acquired diseases of the heart and great vessels. Radiophotography should replace systematic radioscopy in all instances. It should be applied universally at all ages: at the beginning of school and during studies; at the beginning of military service; at the beginning of employment and during work; on the entry of patients to a hospital; and as the first step of health examination of women and the aged. It is to be recommended both because of its harmlessness and its efficacy in diagnosis for numerous applications in the protection of public health. (BBB)

37040 RADIOACTIVE FALLOUT AND ITS IMPORTANCE IN HUMAN PATHOLOGY. D. J. Mewissen (Université, Liège). Rev. Med. Liege, 17: 757-66(Nov. 15, 1962). (In French)

The phenomena connected with various fallout isotopes and their effects in man are discussed. The distribution of energy released by a megaton bomb is diagrammed; and the relative production of fallout from air, underwater, and underground explosions is given. Consideration is directed mainly to explosions at or near the surface. Concentrations of intermediate isotopes in the air after the Nevada tests and thermonuclear tests elsewhere are listed. The relative effects of alpha, beta, and gamma radiation are cited, and relative exposures at various distances are given. External irradiation and internal irradiation (through inhalation, ingestion of vegetables, meat, and water) are evaluated, with emphasis on ^{90}Sr worldwide fallout as a function of latitude. The discrimination factors of physiologic processes are given for the Sr/Ca ratio, and the origins of Sr in bone are outlined with the aid of these figures. The problems with ^{137}Cs fallout are outlined, and its biological effects are outlined. The effect of increase of ^{137}Cs on relative activity levels in the human diet is shown. The number of cases of leukemia consecutive to radioactive fallout exposure is calculated to be 360/yr (milk diet) or 2160/yr (rice diet). Genetic effects of fallout are discussed. The doubling dose (D_{30}) for man from natural sources is equal to 3 rem; that from fallout is estimated at 0.01 rem, and the total number of births with genetic defects resulting from fallout is 300 times smaller than that resulting from natural radiation. (BBB)

37041 RADIOZASHCHITNOE DEISTVIE TSIANISTYKH SOEDENENII (AMYGDALIN). (Radioprotective Effects of Cyanide Compounds (Amygdalin)). V. D. Rogozkii, B. P. Belousev, and N. K. Evseeva. Moscow, Publishing House on Medical Literature, 1963. 131p.

Following a short literature survey on the use of cyanides in acute radiation sickness, the author discusses: preliminary research on the selection of protective compounds; the properties, sources, determination, and toxicity of amygdalin; its effects on body temperature, breathing, the blood-vascular system, diuresis, urine and blood composition, and other factors; and pathological changes. The pro-

tective action of amygdalin compared to that of other compounds leads to the conclusion that amygdalin may be considered among the possibly useful substances for protection against radiation. (IIC-M.G.)

37042 THE EXPOSURE OF THE POPULATION TO RADIATION FROM FALLOUT. A REPORT TO THE MEDICAL RESEARCH COUNCIL BY THEIR COMMITTEE ON PROTECTION AGAINST IONIZING RADIATIONS. John Cockcroft. London, Her Majesty's Stationery Office, 1964. 12p. 1s.

The likely maximum somatic radiation doses attributable to nuclear testing are assessed. Since ^{90}Sr is regarded as the most important single component of fallout, the evaluation is concerned mainly with ^{90}Sr concentrations that may be reached in the bones of young children. Although present levels of ^{90}Sr in bone are only small fractions of the maximum permissible levels, it is emphasized that the full effects of the 1961 nuclear test series are not yet fully reflected in bone measurements and those of the 1962 series are just becoming apparent. Radiation doses to bone from ^{137}Cs, ^{89}Sr, and ^{140}Ba, and total doses to bone and bone marrow from all components of fallout are estimated. Iodine-131 levels in milk are considered, and it is concluded that the uptake in young children is no higher than in adults except transiently in the first few days of life. (H.M.G.)

Radiotherapy and Radiodiagnosis

37043 (A/CONF.28/P/880) ADVANCES IN THE USE OF ISOTOPES AND RADIATION SOURCES IN MEDICINE. E. H. Belcher (International Atomic Energy Agency, Vienna), M. Cohen, R. A. Dudley, H. G. Parker, K. C. Tsien, and H. Vetter. May 1964. 19p.

A review is presented of the developments of the use of radioisotopes and radiation sources for diagnosis and therapy that have taken place since 1958. Recent progress in the availability of isotopes and labeled compounds and developments in instrumentation are reported, as well as recent results of their application to particular diagnostic and clinical research problems. Advances in the therapeutic use of radioisotopes and of radioteletherapy equipment with radioisotopes as radiation sources are also reviewed. (auth)

37044 (UCRL-11387(p.114-26)) ON THE DOSIMETRY OF NEGATIVE PIONS WITH A VIEW TOWARD THEIR TRIAL IN CANCER THERAPY. Chaim Richman, Henry Aceto, Jr., Mudundi R. Raju, Bernard Schwartz, and Mitchel Weissbluth (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

When π mesons come to rest in tissue, they are captured by the heavier elements, mainly C, O, and N, causing the nuclei to explode into short-range and heavily ionizing fragments that are capable of delivering a large localized radiation dose. This capture can be caused to take place in the tumor by selecting the energy of the pion of the required range so that the pion will pass through the healthy tissue and stop in the tumor. The possible advantages of the technique in cancer therapy are reviewed critically. The production of π^- and π^+ mesons and the effect of charged pions in tissue are discussed. Results are reported from preliminary dosimetry studies using a lucite phantom with sheets of x-ray film layered between the slabs or Argon–CO_2-filled ionization chambers using one chamber as a monitor followed by different thicknesses of lucite absorber and using the second ionization chamber as a detector. Results indicate that the presently available pion beams, both positive and negative, can be used for dosimetric evaluations. (C.H.)

37045 THE USE OF ULTRA-SOFT X-RAYS (X-RAY MICROSCOPY) FOR THE STUDY OF AORTIC CALCIFICATION. T. T. Tsaltas (Jefferson Medical Coll., Philadelphia). Am. J. Pathol., 44: 4a(June 1964).

The use of x rays to show Ca in atherosclerotic blood vessels is demonstrated, and the results compared with those of histochemical tests for Ca. The histochemical methods produced Ca positive spots far in excess of the actual amount of Ca present and detectable by chemical analysis. These stains also produced spots that were further blurred by the presence of a halo or nonspecific crystalline precipitates around each Ca deposit. The ultra-soft x rays produced sharply defined spots, well delineated from the surrounding structures. The concentration of Ca evidenced by this method was lower than with any of the histochemical methods. Even though the x rays employed were not monochromatic (ranging from 6 to 40 Å), the great majority of energy after filtration through aluminum consisted of the specific for Ca, K_α lines. This assured that the positive spots produced were due to Ca. Theoretical calculations indicated that more than 90% of the Ca present was detected by this method. (BBB)

37046 GONAD-PROTECTING TUBE FOR HIP RADIOGRAPHY. Dezsoe Markó (Fehérvári Uti Rendelo Intézet, Budapest). Magy. Radiol., 14: 58-61(Jan. 1962). (In Hungarian)

Construction of a pyramid-shaped tube to be used for shielding during hip x-ray examination is described. Since such x-ray examinations are standard practice in Hungary to detect early dislocation of hips in infants, an effective shielding device was needed as most infants will not tolerate the conventional lead shields and repeated exposure may be needed to get a proper picture. A radiolucent tube was constructed with a wedge-shaped lead shield installed at the bottom opening. This allows shielding of the lower half of a child's body, exposing only the hips and upper third of the thighs, however, by increasing the focus distance to 1 m it can be used for adults as well. The shield is pointed down for girls to protect the ovaries and up for boys to shield the testes, giving adequate protection. A light bulb is installed near the x-ray source, above the lead shield, which by the aid of a mirror system casts the shadow of the lead shield on the patient's abdomen. The mirror is positioned exactly halfway between the light bulb and the focus of the x-ray tube, thus the x-ray picture and the lighted area coincide. The radiologist can watch the shadow cast on the patient, and even with a restless child, a good picture may be taken when the child's position is right. This tube is more hygienic than conventional lead shields. The small child is placed on the examining table with his legs bent at the knee and hanging over the edge of the table. This will assure the proper position of the legs for the x ray, and, by holding the legs firmly to the table, the movement of the child is limited. Also, since no parts touch the child, the x-ray examination is usually tolerated quietly. (BBB)

37047 PROBLEM OF CALCULATION OF DOSE IN RADIOCOLLOID THERAPY. G. Scarpa and E. Casnati (Comitato Nazionale per l'Energia Nucleare, [Ispra]). Minerva Nucl., 8: 177-80(May-June 1964). (In Italian)

The problem of calculating the useful dosage of radio-

colloids in their various therapeutic applications was investigated. A critical evaluation of the single parameters involved in the proposed mathematical formulation was carried out. The errors which are possible in the evaluation of the single parameters are considered and their influence on the degree of accuracy of the calculated dose is discussed. In the endopleural and endoperitoneal use of the radiocolloids, when the source has a laminar distribution, the variables most difficult to estimate include the biological half life of the radionuclide; the surface of the serous cavity, and the overall amount of fluid in the cavity. The errors which are possible when estimating other parameters are not very important. These include the initial activity, the average energy of beta particles, the physical half life, and the apparent mass absorption coefficient. It is concluded that the degree of uncertainty of the calculated dose, even if considered as average dose in the whole serous cavity, is rather high being of the order of 25%, while the maximum theoretical error could be several times more. Similar results were obtained in the studies concerning the errors involved with the endovesical inoculation, the intratumoral infiltration and the endovenous injection of the radiocolloids. (auth)

37048 STUDIES ON THE THERAPEUTIC USE OF SHORT PHYSICAL PERIOD RADIOISOTOPES BY MEANS OF ZONAL PERFUSION. EXPERIMENTAL RESEARCH WITH Dy-165. C. Biagini, A. Ficari, E. Bruzzese, A. Centi Colella, and G. Greco (Universita, Rome). Minerva Nucl., 8: 180-6(May-June 1964). (In Italian)

The radiation therapy of malignant tumors using short-lived radioisotopes introduced by regional perfusion was investigated. The production of the ^{165}Dy was carried out by exposure of the stable dysprosium to the neutron flux of a reactor, where protection devices were also supplied. In preliminary researches toxicity studies were performed with the disodium salt of EDTA and with ionic form of stable dysprosium. Tissue distribution of ^{165}Dy-versenate injected into the blood stream was studied in small mammals (mice and rats) by activity measurements of samples and by autoradiographic methods. Results obtained either on normal subjects, or on animals bearing transplanted tumors are reported. Some data are also reported dealing with excretion processes of the isotope and with a mathematical description of the distribution of the radioactivity in tissue. The distribution of ^{165}Dy was then studied in dogs. Special devices were arranged in order to use an extracorporeal circuit with a small pump-oxygenator suitable for the animals. ^{165}-Dysprosium versenate was introduced by intra-arterial perfusion of the extremities and of the cephalic region. Time course of activity in the perfused district and in the total-body was evaluated by use of probes connected with graphical recorders. The amount of leakage was evaluated and the recorded data were compared with results of radioactivity measurements carried out on biological samples (blood and urine). Results are presented on the amount of leakage and on the distribution and excretion of the isotope in different experimental conditions. Data obtained in the regional perfusion of a dog with a spontaneous osteo-sarcoma of the limb are also presented. Some quantitative considerations are given dealing with the possibilities of practical application of the method. (auth)

37049 VIII CONGRESSO NAZIONALE DELLA SOCIETA' ITALIANA DI BIOLOGIA E MEDICINA NUCLEARE, PISA, 3-4 NOVEMBRE 1963. IV SESSIONE SCIENTIFICA. SIMPOSIO SU: LA DOSE ASSORBITA, DISTRETTUALE E TOTALE, NELL'IMPIEGO DIAGNOSTICO E TERAPEUTICO DEI RADIOISOTOPI. (VIII National Congress of the Italian Society of Biology and Nuclear Medicine, Pisa, 3-4 November 1963. 4th Session. Symposium on The Local and Total Absorbed Dose in the Diagnostic and Therapeutic Uses of Radioisotopes). Minerva Nucl., 8: 201-37(July-Aug. 1964).

Separate abstracts were prepared for seven papers covering various aspects of the local and total absorbed radiation dose during diagnostic and therapeutic uses of radioisotopes. (C.H.)

For abstracts of individual papers see: 36985, 37050, 37051, 37052, 37053, 37054, and 37055.

37050 THE RADIATION DOSE TO THE BODY DURING TREATMENT OF THYROTOXICOSIS BY ^{131}I. N. B. Myant (Hammersmith Hospital, London). Minerva Nucl., 8: 207-10(July-Aug. 1964).

Iodine-131 can be used successfully for the treatment of thyrotoxicosis because it is selectively concentrated in the thyroid and retained there for a relatively long time. The time-relations of the metabolic cycle of iodine and the physical properties of ^{131}I are such that the total radiation dose delivered to the thyroid is usually several hundred times the total dose to the plasma. Nevertheless, tissues outside the thyroid do receive significant irradiation. This is due mainly to γ-rays from the thyroid, β rays from ^{131}I circulating in the plasma, and β rays from ^{131}I selectively concentrated by certain organs. The organs receiving the highest γ ray dose from the thyroid are the parathyroids and the pituitary. During the phase when the ^{131}I circulates as iodide, for each millicurie given to the patient, the plasma receives about 0.5 rads, the kidneys and bladder 1 to 3 rads, and the stomach and salivary glands about 20 rads. While the ^{131}I circulates as thyroxine, the dose per millicurie given to the patient is about 3 rads to the plasma and about 10 rads to the liver. Despite the quite large doses of irradiation that must be delivered to the parathyroids, the stomach wall and the liver during treatment for thyrotoxicosis by ^{131}I, there is no evidence that any of these tissues is permanently damaged, nor is there any evidence that in humans cancer tends to arise in thyroid cells that have been irradiated, but not destroyed, by ^{131}I. The incidence of leukaemia after ^{131}I given for thyrotoxicosis is not significantly higher than in the general population. (auth)

37051 ASSESSMENT OF TISSUE RADIATION DOSE IN CLINICAL USE OF RADIOACTIVE INERT GASES, WITH EXAMPLES OF ABSORBED DOSES FROM $^{3}H_2$, ^{85}Kr, AND ^{133}Xe. N. A. Lassen (Bispebjerg Hospital, Copenhagen). Minerva Nucl., 8: 211-17(July-Aug. 1964).

Inert gases can only exist in simple physical solution in the tissues in the organism. Their elimination from the body is therefore solely determined by physicomechanical factors, i.e. solubility, diffusion coefficient, diffusion distance, blood flow, and ventilation. In most clinical uses the interaction of these factors results in a biological half-life which is in the order of minutes. This is very much shorter than for most other isotopes used clinically and it implies that the tissue radiation exposure per unit radioactivity administered is exceedingly low. Thus, with radioactive inert gases, millicurie amounts of radioactivity only result in tissue doses of few millirads. Such amounts can consequently be used, if necessary, without any undue hazard in clinical studies in normal and diseased subjects. The specific radiation problems of three most widely used radioactive inert gases (^{85}Kr, ^{133}Xe, and $^{3}H_2$) are discussed with reference to the various modes of application described. Their low solubility in tissue and blood as com-

pared to air (low partition coefficient tissue : air) implies that the lungs act as a very efficient filter, and also that the lung and airways must be considered the critical organ receiving the highest radiation exposure. (auth)

37052 DOSE PROBLEMS IN THE USE OF RADIOISOTOPES IN DIAGNOSTIC KIDNEY EXAMINATIONS. Karl Zum Winkel (Universität, Heidelberg). Minerva Nucl., 8: 217-22(July-Aug. 1964).

Experience with more than 4000 isotope nephrographies and 290 renal scintigrams showed that diagnostic kidney examinations using radioisotopes give valuable information on functional and morphological conditions in the kidneys without instrumental intervention and without harmful radiation doses to the patient. Factors that reduce the radiation dose are discussed. The radiation dose using ^{131}I-hippuran, ^{125}I-hippuran, ^{203}Hg-neohydrin, ^{197}Hg-neohydrin, ^{203}Hg-salyrgan, or $^{197}HgCl_2$, is presented for normal and pathological kidneys. It is pointed out that the radiation dose during renal scintigraphy is higher than that during isotope nephrography. (C.H.)

37053 PROBLEMS OF ABSORBED DOSE IN THERAPEUTIC USE OF RADIOCOLLOIDS. B. Bellion, S. Chiarle, R. Catolla Cavalcanti, and G. Magistrali (Università, Turin). Minerva Nucl., 8: 223-8(July-Aug. 1964). (In Italian)

Exact knowledge of the dynamics of the biological process responsible for the distribution of radiocolloids used for therapeutic purposes is essential in order to evaluate the dose received by organs and tissues exactly. The results of an investigation on the distribution of various types of radiocolloids injected into the tissues or into the peritoneum in the rabbit are presented, and the factors which condition this distribution are examined. Dose measurements were made by the ionimetric method, adopting a special ionization chamber suitable for experimental determinations, and by the photographic method to assess the dose emitted by various radionuclides at different depths in plexiglass and to measure the maximum distance between sources capable of still giving a therapeutically acceptable uniform dose. The characteristics and advantages of thermoluminescent lithium fluoride dosimeters are described. (auth)

37054 PROBLEMS OF ABSORBED DOSE IN USE OF RADIOISOTOPES IN HEMATOLOGY. P. Ollino (Università, Turin). Minerva Nucl., 8: 228-31(July-Aug. 1964). (In Italian)

The physical characteristics of the radioelements used basically in hematological clinical investigation and in internal radiotherapy of hemopathies are considered. Some concepts and definitions contained in the most recent findings in the field of dosimetry and protectimetry are surveyed. The dose in the critical organs and in the whole organism is evaluated for the most frequent hematological investigations, on the basis of the quantity of radioelement usually used. These dose values are compared with the values of maximum permissible dose advised by the International Commission for protections. A valuation of the local dose in the bone and the integral dose for the radioelement introduced by the intravenous route and the oral route is then made as a function of internal radiotherapy with ^{32}P. Some calculations of the local and total dose are reported after using this method and using panirradiation by means of conventional roentgentherapy and telecobalttherapy. (auth)

37055 PROBLEMS OF TOTAL AND LOCAL DOSE IN USING TRACERS TRAPPED BY THE LIVER. M. F. Becchini (Università, Pisa, Italy). Minerva Nucl., 8: 231-4(July-Aug. 1964). (In Italian)

An account is given of the problems of dosimetry in the use of radioactive tracers trapped by the liver, namely ^{131}I-labeled Rose Bengal, colloidal ^{198}Au, ^{32}P-labeled colloidal chromic phosphate, and denatured ^{131}I-labeled human serum albumin. Liver dosage was measured by determination of the effective half clearance time, which indicates the length of time a tracer remains in the organ. The following values were obtained with a 20 microcurie injection: ^{131}I-labeled Rose Bengal gave a dosage of 90 millirad; colloidal ^{198}Au, 800 millirad; colloidal chromic phosphate, 8.61 rad; ^{131}I-labeled human serum albumin, 29 millirad. Higher doses are required for liver scanning. A 400 microcurie injection gives a liver dose of 1.79 rad with ^{131}I-labeled Rose Bengal and 577 millirad with ^{131}I-labeled serum albumin. A 200 microcurie injection of ^{198}Au gives a liver dose of 7.94 rad. The whole-body dose was then calculated. (auth)

37056 PERIODIC FRACTIONATION OF TREATMENT. Charles Botstein (Montefiore Hospital, New York). Progr. Radiation Therapy, 2: 84-93(1962).

Recent developments in the use of dose fractionation, particularly in supervoltage radiotherapy, to enhance tumor cell radiosensitivity and reduce damage to healthy tissue are reviewed. It is pointed out that no attempt has been made to utilize the skin-sparing effect of the supervoltage radiation for higher dose fractions on the basis of experience gained from grid therapy. An earlier review (in 1958) considering the many combinations of time and dose in radiotherapy revealed three general trends, the applications of which are evaluated. The ^{60}Co irradiation of 65 cancer patients is reported and recommendations drawn. Advantages of the wider spaced fractionation in radiotherapy emphasized are: better general tolerance of treatments by the patient; convenience to the patient through reduction of weekly visits from five to three; convenience to the radiology department by free time for evaluation and follow-up of the patients, for planning, teaching and research; and economic gain for the patient, who gets the total treatment in fewer sessions, and for the department, by making it possible to treat more patients with the same equipment. (TCO)

37057 SMALL-DOSE PREOPERATIVE RADIATION THERAPY. A PRELIMINARY REPORT BASED ON SOME HISTOLOGICAL OBSERVATIONS OF THIRTY RESECTED EPIDERMOID CARCINOMAS OF THE UPPER RESPIRATORY AND DIGESTIVE TRACTS. Malcolm H. McGavran (Washington Univ., St. Louis), Joseph H. Ogura, and William E. Powers. Radiology, 83: 509-19(Sept. 1964).

Small-dose preoperative radiation therapy (1,500 to 3,000 rad tumor dose) was administered to 30 patients with epidermoid carcinomas of the upper respiratory or digestive tracts. All were candidates for primary surgical therapy. Histopathologic changes were found in the resected specimens of the carcinomas of the maxillary antrum, tonsil, larynx, and hypopharynx. In 6 of the 30 cases no carcinoma cells were found histologically, and in 6 others only a few microscopic foci of markedly altered tumor cells were seen. These findings are discussed in the light of more recent concepts in radiation biology. In all but 1 case normal healing of the wound took place. Determination of benefit attributable to such therapy must await analysis of long-term survival. (auth)

37058 ADDITIONAL COMPONENT DOSE OF NEUTRONS IN THERAPY USING FAST ELECTRONS AND ALSO ULTRA-HARD X RAYS. Dietrich Frost and Lothar Michel

(Rudolf-Virchow-Krankenhauses, Berlin). Strahlentherapie, 124: 321-50(July 1964). (In German)

Neutrons as well as high energy nuclear particles are produced during irradiations with photons and electrons using 35-Mev-betatrons. The spectral distribution of the air produced neutrons as well as neutrons and protons produced in tissue equivalent phantoms was determined by means of threshold detectors. The dose values obtained for fast neutron reactions within the phantom are considerably higher than the ones mentioned in literature or calculated. Neutron-depth-dose-curves for photon- and electron radiation were determined. In case of photon radiation of 34 Mev the additional neutron dose is 10%; this dose is only 0.4% with 34-Mev-electrons. This increase is based mainly on a bremsstrahlung background and partly on a electrodisintegration effect. (auth)

CHEMISTRY

General

37059 (A/CONF.28/P/437) THE CAPTURE OF THE RADIOACTIVE NOBLE GASES BY THE CLATHRATE METHOD. Hikaru Shimojima, Yasuyuki Nakayama, Kaname Matsumoto, and Hiromichi Hyodo (Nippon Atomic Industry Group Co. Ltd. Nuclear Research Lab., Kawasaki, Kanagawa Prefecture, Japan). May 1964. 16p.

Clathrate compounds have several important advantages for the waste disposal of radioactive noble gases. Hydroquinone was crystallized from aqueous solutions in argon atmospheres to prepare argon clathrates, and the effects of argon partial pressure, solvent, cooling rate, other gases, etc. on the argon content of the clathrate were determined. Crystal growth and supercooled solutions were studied. The results indicate that the clathrate method should be useful in waste disposal. (D.L.C.)

37060 (A/CONF.28/P/814) UPON THE PHYSICO-CHEMICAL LAWS GOVERNING THE DISPOSAL OF SOME HEAVY RADIOELEMENTS INTO THE GROUND. M. A. Elguebeily and N. Z. Misak (United Arab Republic. Atomic Energy Establishment, Inshas, Egypt). May 1964. 12p.

Studies were made of the adsorption of U and Th on sand and vermiculite. $UO_2(NO_3)_2$ in HNO_3, uranyl carbonate complex in Na_2CO_3 solution, and $Th(NO_3)_4$ in HNO_3 were used. The effects of initial pH, grain size, temperature, and concentration on uptake were studied. Correlations and interpretations of the data were made, and it is concluded that the uptake proceeds by an ion exchange mechanism and is particle diffusion controlled. The data for sand can be described by a Langmuir isotherm, while those for vermiculite can be correlated by a Freundlich isotherm. (D.L.C.)

37061 (A/CONF.28/P/850) THE EFFECT OF LIMING ON THE AVAILABILITY OF PHOSPHATE IN "CERRADO" SOILS OF BRAZIL. E. Malavolta (Brazil. Centro Nacional de Energia Nuclear na Agricultura, São Paulo), O. J. Crocomo, and R. G. Andrade. May 1964. 11p.

The method of isotopic dilution was successfully used to study the influence of limestone in the availability of native phosphorus. "A" values were determined by a simplified technique using samples of cerrado soils previously submitted in the field to the treatment with different amounts of limestone. It has been found out: (1) the three types of cerrado soils had different amounts of available phosphorus; (2) liming increased linearly the "A" values in the case of two of the soils under study; in the third one, however, the response was linear also up to a point wherefrom a further increase in the amount of limestone applied caused a significant drop in available phosphorus. (auth)

37062 (BNL-874(p.14-15)) TECHNICAL AND ECONOMIC CONSIDERATIONS REGARDING COMMERCIAL APPLICATIONS OF WOOD PLASTIC ALLOYS. F. D. Iannazzi and R. S. Lindstrom (Little (Arthur D.) Inc., Cambridge, Mass.).

An evaluation was made on the characteristics, including cost, of materials prepared by irradiating monomer-impregnated wood. The purpose is to characterize the wood alloy products in terms of physical and chemical properties that will contribute to, or limit, their commercial sales potential. A series of graphs were prepared whereby a manufacturing cost can be synthesized based upon various criteria of monomer cost, dosage requirement, irradiating source and efficiency, and production rate. Commercial applications of wood alloys were also studied. (P.C.H.)

37063 (EUR-1641.i) PRODUZIONE DI Mn^{54} CARRIER-FREE PER IRRAGGIAMENTO DI FERRO IN REATTORE. (Production of Carrier-Free ^{54}Mn for the In-Pile Irradiation of Iron). G. B. Fasolo, R. Malvano, and U. Rosa (Società Ricerche Impianti Nucleari. [Centro Ricerche Nucleari], Saluggia, Italy). 1964. 34p.

In order to develop a method for producing carrier-free ^{54}Mn for the in-pile irradiation of pure iron, a study has been carried out on the following points: (1) evaluation of the production yield by checking the $\sigma_t(n,p)$ on ^{54}Fe and tracing the fast flux in certain RSI reactor irradiation positions; (2) selection of the material for irradiation by radioactivation analysis of various types of pure iron, with particular reference to the determination of the concentration of manganese impurities (assessment of ^{54}Mn specific activity obtainable); (3) selection and development of an effective and simple radiochemical separation technique for ^{54}Mn, based on the extraction of iron with solvents (isopropyl ether) and the subsequent purification of the manganese by exchange on an anionic resin column (overall purification factor of the iron $>1 \times 10^6$). Production trials have likewise been performed on both the μC and the mC scale. 9.5 mC ^{54}Mn were produced and separated by irradiating 99.999% iron matrices (35 g total) for two weeks at fast fluxes of 6 to 8.5×10^{12} n–cm^2–sec. The specific activity is 110 C–g Mn; less than 1 μg–ml iron is present in the final solution. (auth)

37064 (NAA-SR-Memo-8712) FISSION PRODUCT RETENTION CHARACTERISTICS OF SODIUM AT HIGH TEMPERATURES. R. S. Hart and C. T. Nelson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). [June 1, 1964]. Contract AT(11-1)-Gen-8. 19p.

Results are given of experiments to determine the retention ability of sodium for Cs-137, I-131, and Sr-89 at temperatures between 900°F and 1500°F. A brief description of the experimental apparatus and the experimental and analytical techniques is also given. For the specific conditions of the experiments, the results show the maximum measured release fractions from the sodium to the cover gas are independent of the sodium temperature and less than 4×10^{-4} for Cs-137, 5×10^{-6} for I-131, and 4×10^{-7} for Sr-89. (auth)

37065 (NAA-SR-Memo-9294(Rev.)) APPENDIX B—SAMPLE PREPARATION FOR SECOND-ROUND CARBON-IN-SODIUM ANALYSIS. R. W. Atz, K. Y. Eng, and H. L. Powell (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 27, 1964. Contract AT-11-1-GEN-8. 24p.

To fulfill the rigid specifications for sample preparation established by the Round Robin Program, a forced circulation system was designed and built. The system and the associated components have performed satisfactorily and three sets of sodium specimens with different carbon concentrations were delivered to nineteen participating laboratories for analysis. (auth)

37066 THE ACTIVATED COMPLEX IN THE COLLISION THEORY OF CHEMICAL KINETICS. L. Blum

(Facultad de Ciencias, Exactas y Naturales, Buenos Aires). Nuovo Cimento (10), 33: 1164-6(Aug. 16, 1964).

It is shown that the very low steric factors observed in many chemical reactions may be explained assuming Breit-Wigner resonances. (auth)

37067 PROCESS FOR PRODUCING BERYLLIUM CHLORIDE FROM BERYLLIUM OXIDE MATERIAL. Ricardo O. Bach (to Beryllium Metals and Chemical Corp.). U. S. Patent 3,146,066. Aug. 25, 1964. Filed Feb. 6, 1962.

A process is given for the direct production of $BeCl_2$ from beryllium ores, particularly beryls. The process comprises reacting the finely divided ore with $SiCl_4$ or BCl_3 at 1000 to 1550°C in the presence of an alkali metal or alkaline earth compound. Examples of the process are given in which the recovery in terms of BeO ranged from 15 to 93%. (D.L.C.)

Analytical Procedures

37068 (A/CONF.28/P/785) A FEASIBILITY STUDY ON NON-DESTRUCTIVE ASSAY OF PLUTONIUM 239 IN IRRADIATED FUEL RODS USING SLOWING DOWN TIME SPECTROMETER. K. Chandramoleshwar, M. P. Navalkar, D. V. S. Ramakrishna, R. Ramanna, and K. R. Subbaramu (India. Atomic Energy Establishment, Trombay). May 1964. 8p.

In the region of 0.01 to 1.0 ev the fission cross sections of ^{235}U and ^{239}Pu are similar except at 0.3 ev where ^{239}Pu has a resonance peak whose value is twenty times that of ^{235}U. This difference is used to determine the plutonium content by measuring the relative macroscopic cross sections as a function of energy in this energy range. Neutrons of various energies are selected using the large slowing-down time and the small energy spread of neutrons slowing down in a heavy moderator. To test the feasibility of the method, a slowing-down-time spectrometer was constructed using about 100 tons of lead (200 × 200 × 190 cm) and a low-voltage pulsed accelerator using the (d,t) reaction as a neutron source. In the experiment, pulses of fast neutrons are injected periodically into the lead assembly. The mean energy and energy spread of the slowing-down neutrons are known as functions of time. The fast neutrons due to fission in samples of plutonium and uranium are measured as a function of slowing down time and hence of energy by using a fast-neutron detector with a time analyzer. The neutron density at the same point is similarly measured by means of a BF_3 proportional counter. Results so far obtained indicate that the method is feasible. (auth)

37069 (A/CONF.28/P.820) DETERMINATION OF RATIO OF U-235 AND U-238 IN URANIUM SAMPLES. A. Ramamoorthy and A. K. Ganguly (India. Atomic Energy Establishment, Trombay). May 1964. 11p.

A method for determining the $^{235}U/^{238}U$ ratio in uranium samples by measuring the buildup of their beta-active daughters, ^{231}Th and ^{234}Th, is described. The results of analyses of samples from different countries are presented, and the merits of the method are discussed in relation to other methods. (D.C.W.)

37070 (A/CONF.28/P/825) NEUTRON COUNTING IN ACTIVATION ANALYSIS. S. Amiel (Israel. Atomic Energy Commission, Tel-Aviv). May 1964. 20p.

Research on the development and use of neutron counting techniques for analysis is reviewed, including analysis of Th and U by counting delayed neutron emission from short-lived fission products; determination of ^{15}N, ^{6}Li, ^{17}O, and ^{18}O and analysis of Li by counting delayed neutrons from 4-sec ^{17}N; analysis of Na, Mn, S, Ca, and Al by photoneutron emission; and determination of ^{18}O using the (α,n) reaction. (D.C.W.)

37071 (A/CONF.28/P/829) DETERMINATION OF CERTAIN TRACE IMPURITIES IN PURE LEAD AND ALUMINIUM BY NEUTRON ACTIVATION ANALYSIS. H. K. El-Shamy, A. A. Abdel-Rassoul, and T. Z. Bishay (United Arab Republic. Atomic Energy Establishment, Inshas, Egypt). May 1964. 14p.

A systematic determination of trace impurities in lead and aluminum is described. A separation scheme based on coprecipitation and ion-exchange techniques is developed. The samples analyzed are irradiated with an activation neutron flux of 1.3×10^{13} n/cm^{2}s together with suitable standards of the elements to be determined. After 7 days cooling, aliquot portions of the irradiated samples are dissolved in a suitable acid after the addition of representative carriers of the elements to be investigated. Both lead and aluminum are readily separable as chloride in excess HCl. The non-precipitable chlorides in concentrated hydrochloric acid are allowed to pass through a column of the strongly basic anionite, Dowex-1, and successfully fractionated with differing HCl/HF concentrations. The metals determined are mainly cobalt, iron, tin, zinc, cadmium, and chromium which are further separated from the corresponding fractions by chemical precipitation. Moreover, the radiochemical purity of the radioactive nuclides concerned was checked before being compared with those induced in the similarly irradiated respective standards. In this respect, the addition of carriers favors the possible purification of the radionuclides separated rather than their fractionation in carrier-free state. The method proposed of successive ion-exchange separation and chemical precipitation thus ensures a complete decontamination from foreign activities. The procedures described can be used for routine analysis with good reproducibility. (auth)

37072 (A/CONF.28/P/854) DETERMINATION OF TRACE ELEMENTS IN THE GREEK LAKES BY NEUTRON ACTIVATION ANALYSIS. A. P. Grimanis, G. Pantazis, C. Papadopoulos, and N. Tsanos (Greece. Atomic Energy Commission, Athens). May 1964. 14p.

Neutron activation analysis was used to determine the stable elements present in microgram and the sub-microgram quantities in Greek lakes at the surface and at 5 and 15 meters. The Democritus Reactor was used as a neutron source. Elements investigated include Ag, Au, As, Ba, Br, Cl, Cu, I, K, Mn, Na, Re, V, and Zn. (R.E.U.)

37073 (A/CONF.28/P/861) RADIOMETRIC ASSAY OF TRACER AMOUNT OF PLUTONIUM IN DEPLETED URANIUM. Vera Maxia, S. Meloni, M. A. Rollier, and R. Stella (Pavia, Italy. Università). May 1964. 4p.

After careful calibration of the ion chamber, with natural uranium, a number of electrodeposited mixtures of Pu–U from depleted uranium were measured for alphas. The mixtures, chemically dissolved from their stainless steel plates, were stripped of their plutonium content and assayed after a second electrodeposition. (auth)

37074 (AED-C-14-03) ACTIVATION ANALYSIS. Series C: Bibliographies. W. Bock-Werthmann, comp. (Hahn-Meitner-Institut fur Kernforschung, Berlin). Feb. 1964. 216p.

An extensive bibliography covering the period May 1962 to

May 1963 is presented, with the references arranged according to reports, conference publications, journal articles, books, dissertations, patents, and industrial publications. Complete indexes are also provided. (D.L.C.)

37075 (AERE-AM-99) THE DETERMINATION OF RADIOSTRONTIUM IN SOLUTIONS CONTAINING LARGE QUANTITIES OF ELEMENTS THAT FORM STRONG COMPLEXES WITH EDTA AT A pH OF 5. G. J. Hunter and Vera F. Mitchell (United Kingdom Atomic Energy Authority. Research Group. Chemistry Div., Woolwich Outstation, England). July 1964. 7p.

Radiochemical exchange is established between radiostrontium and strontium carrier in a solution containing EDTA at a pH of 5. The strontium is recovered as the oxalate, which is dissolved in nitric acid. Conventional purification steps are then used and finally strontium carbonate is precipitated and its activity is measured. This method is to be used in conjunction with AERE-AM3. This method is applicable to solutions of fission products in mixtures of nitric acid and hydrochloric acid containing large quantities of elements that form strong complexes with EDTA at a pH of 5. The coefficient of variation should not exceed 5% when counting statistics permit. (auth)

37076 (IA-925) DIRECT SPECTROCHEMICAL DETERMINATION OF SAMARIUM, EUROPIUM, GADOLINIUM AND DYSPROSIUM IN URANIUM AND ZIRCONIUM. Irena Schoenfeld (Israel. Atomic Energy Commission. Soreq Research Establishment, Rehovoth). Apr. 1964. 23p.

A spectrochemical analysis of uranium for samarium, europium, gadolinium and dysprosium, without prior separation, is presented. The uranium is excited in the chloride form with potassium chloride as buffer, using a 4-amp d-c arc. Under these conditions the heavy background and the complex uranium spectrum are suppressed. The limits of detection for Eu, Sm, Gd, and Dy are 5, 20, 50, and 50 ppm, respectively; the coefficient of variation for Eu and Sm is about 25% for a single determination. The method was extended to the analysis of zirconium. By using a temperature-corrected working curve equation instead of the conventional one, the coefficient of variation for a single determination was lowered from about 50% to 30%. The visually established limits of detection for the four rare earth elements are lower than those reported for direct rare earth analyses in various matrices. With two superimposed exposures 2 ppm europium, 5 ppm dysprosium, 10 ppm gadolinium, and 20 ppm samarium can be determined, using only 35 mg zirconium. (auth)

37077 (PAN-487/IA) A STATEMENT OF THE APPLICABILITY OF FAST NEUTRON ACTIVATION ANALYSIS TO DETERMINE THE COPPER CONTENT IN COPPER DEPOSITS. Ludwik Górski, Włodzimierz Kusch, and Jolanta Wojtkowska (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Dec. 1963. 14p.

A possibility of the application of $^{63}Cu(n,2n)^{62}Cu$ reaction with 14 Mev neutrons, for the determination of copper content in the ores, was investigated. Annihilation radiation from ^{62}Cu β^+ decay was measured by the coincidence method. The relative error is of the order of 2%, and the mean time needed for a single determination is of the order of 4 minutes. The influence of other positron– emitting elements contained in the ores has also been studied; it results in an average overestimate of the copper content of about 0.06% Cu. It has been shown that the method can be applied when the demand for analyses is a few hundred per day. (auth)

37078 (PG-Report-575) ANALYTICAL METHOD FOR THE ABSORPTIOMETRIC DETERMINATION OF PHOSPHORUS IN URANIUM OXIDES. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1964. 5p.

The sample is dissolved in nitric acid and just neutralised with ammonia. Ammonium molybdate is added to convert the phosphorus to the heteropoly acid which is then reduced with stannous chloride to "molybdenum blue" and determined absorptiometrically. The method is applicable to samples containing from 1 to 16 ppm phosphorus and assumes that no organic phosphorus is present. At the 6 ppm level the standard deviation is 0.5 ppm. (auth)

37079 QUANTITATIVE X-RAY FLUORESCENCE ANALYSIS OF RARE-EARTH OXIDE MIXTURES USING DILUTION PARAMETER TECHNIQUE. Ken-ichi Tsutsumi (Mitsui Mining and Smelting Co., Ltd., Tokyo). Bunseki Kagaku, 13: 635-45(July 1964). (In Japanese)

A dilution-type technique named the dilution parameter method with strontium carbonate as a diluent is described for the quantitative x-ray fluorescence analysis of mainly heavy rare-earth oxide mixtures, which are in multicomponent systems of widely varying compositions. The final calculating equation included two terms of the direct standard comparison and the dilution parameter correction in the form of product. Although precision and accuracy vary widely to some extent depending on the concentration of analytical component, overall the average coefficient of variation and error evaluated from the analysis of many synthetic samples in the concentration range 5 to 90% is about 3 and several %, respectively. If some improvements are carried out, it may be expected that the proposed method is recommended for the rare-earth analysis because of its simplicity and reasonable accuracy. (auth)

37080 QUANTITATIVE X-RAY FLUORESCENCE ANALYSIS OF YTTRIUM IN RARE-EARTH OXIDE MIXTURES AND XENOTIME ORES. Ken-ichi Tsutsumi (Mitsui Mining and Smelting Co., Ltd., Tokyo). Bunseki Kagaku, 13: 645-54(July 1964). (In Japanese)

From viewpoints of the internal standard method with strontium carbonate as a standard material and the dilution parameter method with strontium carbonate for oxides and iron oxide for ores as respective diluents, the powder-type x-ray fluorescence analysis of yttrium in rare-earth oxide mixtures and xenotime ores containing yttrium oxide over 0.n% is described. Both the coefficients of variation of analytical results and the analytical errors are several % at the highest, and the total minutes required for the analysis per one sample are usually within 20 in each case. The internal standard method is recommended for the analysis of yttrium alone and the dilution parameter method is advantageous in conjunction with multicomponent analysis. (auth)

37081 THE USE OF BREMSSTRAHLUNG RADIATION FROM β EMITTERS IN ORDER TO EXCITE A PHOTONUCLEAR REACTION. I. N. Plaksin, N. G. Malysheva, and L. P. Starchik (Skochinskii Inst. of Mining, [Academy of Sciences,] USSR). Dokl. Akad. Nauk SSSR, 156: 803-5 (June 1, 1964). (In Russian)

Nuclear (γ,n) reactions have the lowest thresholds for ^{9}Be (1.63 Mev) and for D (2.23 Mev). The photoneutrons from these reactions can be counted to determine the beryllium or deuterium content in a material. Natural radioactive elements such as Ra and MsTh can be used as gamma sources, but their cost is high. Artificial radioactive elements such as ^{24}Na, ^{56}Mn, ^{72}Ga, ^{88}Y, ^{124}Sb, and ^{140}La are suitable for use, but are limited by their short half lives

or unavailability. Bremsstrahlung radiation from $^{90}Sr-^{90}Y$ (E_{max} = 2.27 Mev), $^{106}Ru-^{106}Rh$ (E_{max} = 3.55 Mev), and $^{144}Ce-^{144}Pr$ (E_{max} = 3.15 Mev) were evaluated as suitable sources of γ rays. It is shown that these sources can be used for the determination of beryllium and deuterium. The long half life and ready availability of these fission products make these bremsstrahlung sources of γ rays attractive for use in this analytical application. (TTT)

37082 THE GEOCHEMISTRY OF TIN. Hiroshi Hamaguchi, Rokuro Kuroda, Naoki Onuma, Kazuaki Kawabuchi, Tetzuya Mitsubayashi, and Kyoichi Hosohara (Tokyo Kyoiku Univ.). Geochim. Cosmochim. Acta, 28: 1039-53(July 1964).

In order to obtain more reliable and comprehensive geochemical figures about tin, neutron activation analyses were undertaken for widely selected materials of geochemical interests. Analyses are given for 35 silicic (av. 3.6 ppm Sn), 19 intermediate (av. 1.5 ppm), 3 mafic (av. 0.9 ppm), and 4 ultramafic rocks (av. 0.35 ppm). Data for 10 red clays (av. 4.9 ppm), 3 globigerina oozes (av. 1.5 ppm) and 4 volcanic muds (av. 1.4 ppm), all of them collected from the Pacific Ocean, and 3 red clays of the Japan Sea (av. 4.1 ppm) are also given. The results on the abundance values for tin in various types of igneous rocks, as well as of red clays, confirm the figures given by others. Contrary to the previous information about the geochemistry of tin, it was found that tin should be thought of as being distributed as a trace element rather evenly throughout the crustal rocks. Pelagic sediments do not show any marked enrichment of tin compared with igneous rocks. The striking similarity in the concentrations of tin in the pelagic argillaceous sediments, terrestrial clays, and igneous rocks suggests a mainly terrigenous origin for the deep-sea sediments rather than one involving the submarine weathering of volcanics and pyroclastics. Sea water samples of the Pacific Ocean give the value of 0.81 μg Sn/l as an average. The enrichment factor for tin for marine animals is estimated to be about ~2400 to a good order of magnitude. (auth)

37083 A METHOD FOR THE EXTRACTION OF TRACE ELEMENTS FROM SEA WATER. D. Lal, J. R. Arnold, and B. L. K. Somayajulu (Tata Inst. of Fundamental Research, Bombay). Geochim. Cosmochim. Acta, 28: 1111-17(July 1964).

A simple technique is described that permits an in situ extraction of many elements present in trace quantities in sea water. The basis of the technique is adsorption of the elements on ferric hydroxide. A matrix of finely dispersed ferric hydroxide gel, using fibrous jute or spongin as the framework, is constructed through which water can flow freely; this matrix is towed through sea water permitting an in situ extraction of elements from large quantities of water. Four elements present in concentrations ranging from ca 10^{-4} to 10^{-9} g/l of sea water were extracted from the equivalent of a few hundreds of tons of coastal waters. In the beryllium and silicon extracts the radioactivities due to cosmic ray produced isotopes ^{7}Be and ^{32}Si were measured. The extraction technique described should prove valuable for studying the distribution and isotopic composition of several trace elements present in sea water as well as in lakes or rivers. (auth)

37084 GRAVIMETRIC ESTIMATION OF MOLYBDENUM(VI) USING α-NITROSO-β-NAPHTHOL. S. V. Patil (Karnatak Univ., Dharwar, India). Indian J. Chem., 2: 317-18(Aug. 1964).

Molybdenum(VI) is quantitatively precipitated by α-nitroso-β-naphthol between pH 1 and 2.3, and the precipitate is weighed as oxide after ignition to MoO_3. Interference due to iron(III), vanadium(V), and titanium(IV) can be eliminated by masking them with EDTA. Estimation of Mo(VI), in binary mixtures with U(VI), Co(II), and Cu(II), was carried out by precipitating U(VI), Co(II), and Cu(II) at appropriate pH levels and finally precipitating Mo(VI) between pH 1 and 2.3. (auth)

37085 POLAROGRAPHY OF THORIUM AT DROPPING MERCURY ELECTRODE IN LITHIUM CHLORIDE MEDIUM. R. S. Saxena and M. L. Mittal (Government Coll., Kota, India). Indian J. Chem., 2: 333-5(Aug. 1964).

An irreversible wave with half wave potential -1.27 v. (versus SCE) was observed for Th^{4+} in 1M lithium chloride as the supporting electrolyte and gelatin (0.01 per cent) as the maxima suppressor. The effects of change of temperature, height of the mercury column, and concentration were also investigated. The values of temperature coefficients, $i_d/^{h^{1/2}}eff.$ and non-linearity of wave height with Th^{4+} ion concentration indicate that the wave produced by thorium ions is catalytic. The wave is neither diffusion controlled nor reproducible and well defined. (auth)

37086 NEUTRON ACTIVATION STUDIES OF BIOLOGICAL FLUIDS: MANGANESE AND COPPER. E. L. Kanabrocki, T. Fields, C. F. Decker, L. F. Case, E. B. Miller, E. Kaplan, and Y. T. Oester (Veterans Administration Hospital, Hines, Ill.). Intern. J. Appl. Radiation Isotopes, 15: 175-90(Apr. 1964).

A detailed description of a procedure is presented for estimation of non-dialyzable manganese and copper in biological fluids by neutron activation. A 1-ml sample of serum or cerebrospinal fluid is serially dialyzed against 10-ml aliquots of ammonium barbituric acid buffer, pH 7.35, in a period of less than 3 hr. The dialyzed samples are then irradiated and analyzed for manganese and copper by γ spectroscopy. Analysis of sera obtained from 30 adult, apparently healthy male subjects, revealed concentration of non-dialyzable manganese as 1.3 ± 0.2 $\mu g\%$ and that of copper as 164 ± 41 $\mu g\%$. Bloods collected from eight hospitalized male subjects with clinical diagnosis of myocardial infarction revealed serum manganese elevations over those of normal male levels. These manganese elevations apparently were not related to elevations of sera transaminase concentrations. Cerebrospinal fluid analysis of 12 hospitalized male subjects without known organic disease of central nervous system and with normal cerebrospinal fluid protein revealed the following non-dialyzable concentrations: manganese 0.4 ± 0.12 $\mu g\%$ and copper 27.8 ± 16.1 $\mu g\%$. (auth)

37087 THE DETERMINATION OF SPECIFIC ACTIVITY OF $BaC^{14}O_3$ BY LIQUID SCINTILLATION ASSAY. J. A. Kornblatt, P. Bernath, and J. Katz (Cedars of Lebanon Hospital, Los Angeles). Intern. J. Appl. Radiation Isotopes, 15: 191-4(Apr. 1964).

A procedure was developed whereby both mass and radioactivity of CO_2 may be rapidly and easily measured. Essentially the procedure involves precipitation of $^{14}CO_2$ as $BaCO_3$ on tarred filter papers, determination of the mass of $BaCO_3$ gravimetrically and regeneration and absorption of the $^{14}CO_2$ in toto into ethanolamine. The procedure eliminates aliquoting and transferring, and uses cheap, readily available equipment. (P.C.H.)

37088 HIGH-PRECISION ABSOLUTE GAS COUNTING OF TRITIUM. II. CHARACTERISTICS AND CONSTRUCTION OF INTERNAL GAS COUNTERS ESPECIALLY FOR HYDROGEN–METHANE MIXTURES. A. Spernol and

B. Denecke (Euratom, Geel, Belg.). Intern. J. Appl. Radiation Isotopes, 15: 195-211(Apr. 1964). (In German)

A method for the determination of the activity of tritiated water samples with a reproducibility of 0.1–0.2% and an absolute accuracy of 0.3–0.4% is described in detail. A description of the construction and operating characteristics of the internal gas counters used is given. (auth)

37089 HIGH PRECISION ABSOLUTE GAS COUNTING OF TRITIUM. III. ABSOLUTE COUNTING OF TRITIUM IN THE INTERNAL GAS COUNTER. A. Spernol and B. Denecke (Euratom, Geel, Belg.). Intern. J. Appl. Radiation Isotopes, 15: 241-54(May 1964). (In German)

A method of determination of the activity of tritiated water samples with a reproducibility of 0.1–0.2% and an absolute accuracy of 0.3–0.4% is described in detail. The counting procedure and its systematic errors are discussed. (P.C.H.)

37090 LIQUID SCINTILLATION COUNTING OF C^{14} USING A BALANCED QUENCHING TECHNIQUE. H. H. Ross (Oak Ridge National Lab., Tenn.). Intern. J. Appl. Radiation Isotopes, 15: 273-7(May 1964).

A new method was developed for liquid scintillation counting of ^{14}C at a constant, known efficiency in quenched samples. The technique eliminates the manipulation and calculation problem of other methods of yield correction and avoids the radiochemical contamination inherent in the internal standard method. Once initial counting conditions have been established for a given sample type, count rate can be read directly from the instrument at a predetermined counting efficiency. This balanced quenching technique is insensitive to differences in activity levels from sample to sample and small shifts in instrument operating parameters. The proposed method does not require the use of counting instruments with dual scalers or coincidence circuitry but backgrounds are reduced significantly with coincidence operation. The method is ideally suited for routine counting of similar types of samples in any activity range. (auth)

37091 THE EXTRACTION OF INDIUM AND GALLIUM WITH DI-N-BUTYL PHOSPHATE. András Kiss. Magy. Kem. Folyoirat, 70: 197-201(May 1964). (In Hungarian)

The possibility of extraction of indium and gallium with HDBP dissolved in n-butanol and CCl_4 was examined when the aqueous phase contained various concentrations of HCl. It was established that the extraction shows a maximum for ions of both metals at p_H 4–5. The gallium and indium hydroxides can be extracted into HDBP. The indium and gallium can be separated from accompanying ions, if the phase containing the HDBP-metal ion complex is reextracted by nitric acid. The aqueous phase contains the indium and gallium whereas the other metal ions such as U, Ti, and Th remain forming a molecular compound bonded to HDBP in the organic phase. Because of different stabilities of the HDBP complexes of indium and gallium these ions may be separated from each other. In the HDBP complex of indium and gallium one mole of metal ion is connected to three moles of HDBP in both cases. (auth)

37092 RAPID NON-DESTRUCTIVE ANALYSIS OF OXYGEN BY NEUTRON ACTIVATION. Yuichiro Kamemoto (Japan Atomic Energy Research Inst., Tokyo). Nature, 203: 513-14(Aug. 1, 1964).

An activation method applied to the determination of oxygen in organic compounds is described. Pure water was used as an oxygen standard. Oxygen was determined by comparing the peak height of 0.200 Mev gamma ray with that of the standard. The upper and lower limits of determination of oxygen are about 6 and 0.1 g, respectively. (P.C.H.)

37093 DETERMINATION OF THORIUM WITH FLAVONOL-2'-SULFONIC ACID. Yoshinaga Oka, Katsumi Yamamoto, and Tadashi Aoki (Tohoku Univ., Sendai). Nippon Kagaku Zasshi, 85: 430-4(July 1964). (In Japanese)

In an acid solution of the concentration 0.1 N to pH 2.0, a 1:1 chelate with an absorption maximum at 365 mμ was found to be formed between flavonol-2'-sulfonic acid and thorium. Within the pH range 6.0 ~ 7.0, a 1:2 chelate was formed, and its absorption maximum was found to be at 373 mμ. The stability constants of the 1:1 and 1:2 chelates were 1.9×10^{10} and 6.0×10^{7}, respectively at 0.50 of ionic strength (25°C). The thermodynamic acid dissociation constant of sodium flavonol-2'-sulfonate was found to be 6.0×10^{-10} at 25°C. Thorium can be determined by the use of this 1:2 chelate at the concentration as low as 0.16 γ/ml. Beer's law was obeyed in the solution. The molar extinction coefficient of the 1:2 chelate was 32700 at 373 mμ. (auth)

37094 SPECTROPHOTOMETRIC STUDY OF THE REACTION BETWEEN THORIUM NITRATE AND CHROMOTROPE 2R. SPECTROPHOTOMETRIC DETERMINATION OF THORIUM. D. Negoiu and M. Nasea (Bucharest Univ.). Studia Univ. Babes-Bolyai, Ser. Chem., No. 1, 39-48(1963). (In Rumanian)

A spectrophotometric study of the reaction between Th(IV) and chromotrope 2R revealed the formation of two compounds with Th(IV)/chromotrope 2R ratios of 1:1 and 2:1. The two reactions permit spectrophotometric determination of Th quantities between 0.56 and 0.28 μg/ml. (D.C.W.)

37095 SEPARATION OF RADIOIODINE FROM TELLURIUM BY THE RADIOCHROMATOGRAPHIC METHOD. Gheorghe Marcu and Florian Tolea (Babes-Bolyai Univ., Cluj). Studia Univ. Babes-Bolyai, Ser. Chem., No. 1, 101-5(1963). (In Rumanian)

A method is described for separating the iodine from the iodide in the system $TeO_3^{2-} + IO_3^- + I^-$ by radiochromatography on paper. The best solvents are n-propyl alcohol–ammonia (4:1) and n-propyl alcohol–pyridine–ammonia 4:2:1. (D.C.W.)

37096 ANALYSIS OF SODIUM HYDROXIDE SOLUTIONS BY THE BETA RADIATION BACKSCATTERING METHOD. Gheorghe Marcu and Gheorghe Murgu (Babes-Bolyai Univ., Cluj). Studia Univ. Babes-Bolyai, Ser. Chem., No. 1, 107-12(1963). (In Rumanian)

The dependence of the intensity of beta radiation reflected from NaOH solutions on the concentration of NaOH and on the concentration of NaCl in the solution was studied. ^{204}Tl sources proved to be better than ^{32}P and ^{185}W sources. From the results, a method was developed for analyzing NaOH solutions and for determining NaCl contents in excess of 5%. (D.C.W.)

37097 PHOTOMETRIC DETERMINATION OF THORIUM WITH GALLEINE. L. Kekedy and G. Balogh (Babes-Bolyai Univ., Cluj). Studia Univ. Babes-Bolyai, Ser. Chem., No. 1, 199-204(1963). (In Rumanian)

Gallein (4,5 dioxy-fluorescein) in nitric acid medium (pH ~ 2,5) gives with Th a combination of violet color. This color reaction was used for the photometric determination of small quantities of Th. The reagent was a 10^{-4} molar aqueous-alcoholic (4%) solution of gallein. The composition of Th galleinate was determined by Job's method, the mole-ratio method, the slope-ratio method,

and the method of Asmus. The effect of various elements and ions on the determination was determined. (auth)

37098 GALLEINE, A NEW METALLOCHROMIC INDICATOR FOR THE COMPLEXOMETRIC DETERMINATION OF THORIUM. L. Kekedy and G. Balogh (Babes-Bolyai Univ., Cluj). Studia Univ. Babes-Bolyai, Ser. Chem., No. 1, 205-6(1963). (In Rumanian)

In nitric acid medium (pH ~ 2,3) Th can be determined complexometrically using gallein as a metallochromic indicator. At the equivalence point the color turns from reddish violet to yellow. The color change can be screened with metylene blue. The indicator reagent is a saturated alcoholic solution of gallein. 2 to 100 mg quantities of Th were determined with 0.02 molar EDTA with good results. Fe(III), Bi, Sb(III), Sn(IV), Ce, Tl Zr, U, the halogen ions, tungstate and sulfate interfere. (auth)

37099 PHOTOMETRIC DETERMINATION OF ZIRCONIUM WITH GALLEINE. L. Kekedy and G. Balogh (Babes-Bolyai Univ., Cluj). Studia Univ. Babes-Bolyai, Ser. Chem., No. 1, 207-13(1963). (In Rumanian)

The color reaction of gallein with Zr in nitric acid medium can be used for the photometric determination of Zr. The reagent (10^{-4} molar) is prepared by dissolving gallein in 40 ml of ethyl alcohol and diluting the solution with H_2O to 1 l. Tn nitric acid at pH ~ 2.3, Zr gives a combination of violet color in which the gallein : Zr ratio is 2 : 3. The maximum color intensity develops in 10 min, and the content of Zr is obtained from a calibration curve. Tones which give similar color reactions interfere. (D.C.W.)

37100 FURTHER STUDIES ON THE PRODUCTION OF CARRIER-FREE SULFUR-35 FROM PILE IRRADIATED POTASSIUM CHLORIDE TARGETS. A. A. Abdel-Rassoul and A. Abdel-Aziz (Atomic Energy Establishment, Inchass, Egypt, U.A.R.). Z. Anorg. Allgem. Chem., 330: 91-5(June 1964).

A simple method was developed for separating carrier-free ^{35}S from neutron-irradiated KCl in high chemical, radiochemical, and medical purity. The product was proved to be free from any contaminating ^{32}P activity, in which case, the behavior of carrier-free ^{35}S and ^{32}P on the strongly basic anion exchanger, Dowex-1, was studied and the optimum conditions of their separation were used. The method can be successfully applied on a production scale for any level of ^{35}S activity with a minimum consumption of chemicals and practically no consumption of resin. An illustrative flow sheet is given. (auth)

37101 PREPARATION OF CARRIER-FREE SCANDIUM-48 FROM PILE IRRADIATED VANADIUM TARGETS. A. A. Abdel-Rassoul and S. Mohammad (Atomic Energy Establishment, Inchass, Egypt, U.A.R.). Z. Anorg. Allgem. Chem., 330: 96-100(June 1964).

A method is described for the separation and purification of carrier-free ^{48}Sc activity from vanadium targets irradiated in the Inchass 2 MW-Research Reactor. Solvent extraction techniques followed by ion exchange separation were successfully applied to decrease chemical impurities to a minimum. The radiochemical purity of the product (>99%) was checked by following the corresponding decay curve as well as by careful gamma energy determination using a 100-channel pulse height analyzer. An illustrative flow-sheet for processing the irradiated targets is given. (auth)

37102 PHOTOMETRIC DETERMINATION OF ZIRCONIUM IN NIOBIUM AND OTHER METALS. S. V. Elinson and T. I. Nezhnova. Zavodsk. Lab., 30: 396-9(1964). (In Russian)

A photometric method of determining microgram quantities of Zr in metallic niobium is described, based on forming a colored zirconium complex with xylenol orange in 0.4N H_2SO_4 with hydrogen peroxide retaining the niobium. The sensitivity of the method was 0.005%. (R.V.J.)

37103 METHOD FOR DETERMINING SMALL QUANTITIES OF CERIUM. E. I. Rudenko and M. I. Shvaiger. Zavodsk. Lab., 30: 400-1(1964). (In Russian)

Small amounts of Ce in steel were determined by a nephelometric method. Ce was oxidized to Ce(IV) by using a bromate and iodate mixture. The optical density of the solutions increased proportionately with the increase of Ce concentration at the investigated range of 0.05 to 0.3 mg in 50 ml of solution. The optical density of the nephelometric solutions increased during the first 30 min, after which it dropped. The diagram of otpical density of the solution as a function of time is given. The sensitivity of the method is ±0.001%. (R.V.J.)

37104 COMPARATIVE STUDIES OF COLORIMETRIC DETERMINATION OF ZIRCONIUM. S. B. Savvin and Yu. M. Dedkov (Vernadskii Inst. of Geochemistry, USSR and Inst. of Analytical Chemistry, Academy of Sciences, USSR). Zavodsk. Lab., 30: 645-7(1964). (In Russian)

The results of a comparative study of a series of reagents for photometric determination of Zr are presented. Two of the reagents studies were nitrosulfophenol C and picramine P. With the latter reagent it is possible to determine Zr in the presence of large amounts of Th, UO_2^{++}, and rare earths, and also in colored solutions. (tr-auth)

37105 DETERMINATION OF ZIRCONIUM IN CAST IRON USING CHLORSULFOPHENOL. Yu. M. Dedkov, D. S. Kadaner, N. D. Pisarenko, A. S. Ryabova, and S. B. Savvin. Zavodsk. Lab., 30: 654-5(1964). (In Russian)

A photometric method is presented for determining Zr in cast iron with chlorosulfophenol C in the presence of large amounts of iron, which reduces hydroxylamine. The analysis requires 2.5 hr, and the average relative error is 2 to 3%. (tr-auth)

37106 ON THE DEVELOPMENT OF DEVICES FOR THE DETERMINATION OF TOTAL BODY RADIOACTIVITY IN MAN: A HISTORICAL AND CRITICAL REVIEW. B. Rajewsky, A. Kaul, and J. Heyder (Max-Planck-Institut für Biophysik, Frankfurt am Main). Vienna, International Atomic Energy Agency, 1964, Preprint SM-52/58. 46p. (CONF-448-22)

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, May 1964.

The experimental possibilities of the direct and indirect determination of radioactive incorporations within the human body are discussed in a historical and critical review. 93 references. (C.H.)

37107 BERYLLIUM MONITOR MEANS UTILIZING AN ELECTRIC ARC AND SPECTRUM ANALYZER. Robert John Webb, Maurice Stephen William Webb, and Peter Charles Wildy (to United Kingdom Atomic Energy Authority). U. S. Patent 3,144,551. Aug. 11, 1964. Filed Mar. 28, 1960.

An apparatus is designed for the direct spectrographic determination of an element, particularly Be, in a gas. The determination is unaffected by Be particle sizes up to 50 μ and is accurate to ±30% for concentrations < 80 $\mu g/m^3$ and a sampling time of 20 sec. (D.L.C.)

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Refer also to abstract 37674.

37108 (A/CONF.28/P/349) CHEMICAL AND ELECTROCHEMICAL BEHAVIOUR OF TECHNETIUM IN AQUEOUS SOLUTIONS. Vict. I. Spitsyn, A. Th. Kuzina, N. N. Zamoshnikova, and A. A. Oblova (U.S.S.R.). May 1964. 20p.

Data are presented on chemical and electrochemical properties of some valence states of technetium from polarography and spectrometry. A study was made of the polarographic recovery of pertechnetate ion by means of a dropping mercury electrode against various backgrounds. Diffusion and catalytic processes in electrical reduction of pertechnetate ion in various media were established. Conditions for obtaining different valence of technetium were found. The stability of the oxidation states of technetium VII, VI, IV and metal in alkaline, acid and neutral media were studied. An investigation of the absorption properties of technetium was made using scarcely soluble precipitates of molybdates, tungstates and phosphates. A study was made of electrolytic deposition of technetium from sulfurous acid, pH 2, and ammonium sulfate, pH 5.6, solutions of pertechnetate ion with constant potentials of the platinum electrode used. For measuring the rates of electrodeposition of technetium, the critical potentials of its deposition from these solutions were found. A calculation was also made of the standard potential for technetium oxide, which proved to be close to published data. It was established that electrodeposition of technetium takes place with a great overvoltage. Deposits formed on the cathode are not of a clearly crystalline character, and their structure can be revealed after additional annealing. X-ray patterns of electrolytic deposits exhibit not only the lines of technetium metal but also lines whose parameters should be attributed to technetium in some oxidation state. They are close to the parameters of the MnO_2 tetragonal lattice. The presence of color reactions of technetium with a number of organic substances provided for new methods of determination by extraction with acetone and subsequent photometry. (T.R.H.)

37109 (A/CONF.28/P/353) HETEROGENEOUS OXIDATION OF UO_2 AND URANIUM LEACHING PROCESSES IN ACID SOLUTIONS. E. A. Kanevsky, A. P. Philippov, and G. M. Nesmeyanova (U.S.S.R.). May 1964. 19p.

A study was made of the kinetics of dissolution of UO_2 as affected by various oxidizers. The kinetics of oxidation by manganous dioxide in sulfuric acid solution is mainly determined by the conditions of contact of the solid phases. Fe(III) ions function as direct oxidizers in spite of the lower oxidation-reduction potential of this sytem. The investigation of the oxidation of UO_2 by Fe(III) ions shows the high effectiveness of the hydrolyzed ions $FeOH^{2+}$ and $Fe(OH)_2^+$. In the presence of HNO_3 the kinetics of oxidation and dissolving of UO_2 is determined by the rate of destruction of HNO_3, and the presence of Fe(III) ions does not have as much importance as in the system UO_2-MnO_2- Fe(III). At low temperature Fe(III) ions do not accelerate the process. The investigation of the kinetics of oxidation of U(IV) in solution by the chlorites shows that the active part of the oxidizer is the products of chlorite destruction. The rate of the interaction of UO_2 with the chlorates in the acid solution is determined by the concentration of undissociated chloric acid. An explanation of the slowness of the reaction at low temperature is given. The catalytic influence of the iron and vanadium ions on this process was investigated. (auth)

37110 (A/CONF.28/P/464) THE PRODUCTION OF URANIUM TETRAFLUORIDE BY THERMAL DECOMPOSITION OF AMMONIUM URANOUS FLUORIDE IN A FLUIDIZED BED. R. E. Robinson (Union of South Africa. Atomic Energy Board, Pretoria), J. C. Geertsma, and J. C. Paynter. May 1964. 16p.

A pilot plant designed to produce approximately 100 tons of uranium tetrafluoride per year is described. The plant consists of a fluidized bed reactor in which the ammonium uranous fluoride is calcined in a stream of nitrogen, a system for the recovery of the ammonium fluoride from the effluent gases, and a system for recycling the nitrogen gas. Details are given of the design and construction of the fluidized bed reactor, materials of construction, and the fluidization characteristics of the ammonium uranous fluoride. Two systems for the recovery of ammonium fluoride are described. The first involves the condensation of ammonium bifluoride as a liquid at a carefully controlled temperature; the second uses a cooling chamber to condense the gas to form a solid powder. (auth)

37111 (A/CONF.28/P/702) ON THE URANIUM–HYDRAZINE SYSTEM. B. S. Brcic, J. Slivnik, D. Kolar, B. Frlec, M. Komac, and P. Glavic (Nuklearni Institut "Josef Stefan," Ljubljana, Yugoslavia). May 1964. 20p.

Several reactions of the non-aqueous and aqueous hydrazine with different uranium salts (UF_6, UF_4, $UO_2(NO_3)_2$, etc.) are described, which could be possibly used as intermediate steps in the preparation and purification of uranium fuels. The products of the reaction of non-aqueous hydrazine with uranium fluorides (UF_6 and UF_4) were analyzed and compared with compounds obtained by the reaction of hydrazine fluoride with metallic uranium and uranium oxides. In the system hydrazine hydrate–uranyl nitrate–water different precipitates with uranium in (+6) and (+4) valence states were obtained depending on the reaction conditions. The precipitates were decomposed and several uranium oxides were found to be formed during the decomposition process. The basic apparatus for the experimental work under specified conditions is also described. (auth)

37112 (A/CONF.28/P/749) STUDY OF THE HIGH-TEMPERATURE BEHAVIOUR OF URANIUM OXIDES AND OF THE KINETICS AND MECHANISM OF FORMATION OF URANIA–THORIA SOLID SOLUTIONS. M. D. Karkhanavala, A. C. Momin, A. M. George, V. D. Damani, N. Singh, and V. Amirthalingam (India. Atomic Energy Establishment, Trombay). May 1964. 20p.

Results are given of studies on the high temperature chemistry of the oxides in the system $UO_2-ThO_2-O_2$ with special reference to the kinetics and mechanism of formation of solid solutions. It is shown that the mechanism by which U_3O_8 reacts with ThO_2 in air at temperatures $\geq 1000°C$ to form a solid solution involves a gas phase. The importance of this gas phase reaction in fabricating high density fuels is discussed. On the basis of a study of similar reactions with other oxides (Al_2O_3, SiO_2, CaO, HfO_2, ZrO_2, and stabilized ZrO_2), it is shown that the reaction involving gaseous UO_3 proceeds only if the substrate material on which it condenses has a cubic symmetry. Thus, no reaction is observed with non-cubic oxides [Al_2O_3, SiO_2, ZrO_2 (below about 1250°C)], noticeable reactions with the high temperature pseudo-cubic modifications, and strong reactions with cubic oxides. For elucidating the kinetics of

U_3O_8–ThO_2 reactions, the high temperature behavior and kinetics of weight loss from nuclear pure U_3O_8 have been studied in the temperature range 1200 to 1500°C. The isothermal weight loss from U_3O_8 heated in air is found to vary linearly with exposed surface area and to follow a first order kinetics with an energy of activation of 104 kcal/mole and an entropy of activation of 30.5 eu. In U_3O_8–ThO_2 mixtures there is a very sudden initial weight loss. The period over which this weight loss occurs increases with decreasing temperature. The end of this period corresponds with about 80% solid solution formation, after which the isothermal weight loss obeys first order kinetics with an energy of activation of 74 kcal/mole and an entropy of activation of 16.5 eu (values for 50 mole % mixture). The volatilizing species is a pure uranium oxide. This volatility of urania–thoria is discussed from the point of view of stability of such fuels at high temperatures. The kinetics of solid solution formation obeys Jander's equation. Arrhenius plot gives an energy and entropy of activation of 41.5 kcal/mole and 6.3 eu respectively. During the high temperature studies of U_3O_8, it is observed that on extremely slow cooling (100°/day) from temperatures greater than 1100°, a different phase of U_3O_8 appears. The structural relationship of this phase with the Rundle phase, and α–U_3O_8 are discussed in terms of the "out-of-step" stacking faults. (auth)

37113 (A/CONF.28/P/763) ON THE DETERMINATION OF THE DIFFUSION CONSTANTS OF H_2O, PHENYLS, $ZrH_{1.26}$, AND D_2O BY NEUTRON SINGLE-SCATTERING EXPERIMENTS. T. Springer (Kernforschungsanlage, Julich, Germany), Ch. Hofmeyr, S. Kornbichler, and H. D. Lemmel. May 1964. 19p.

The average thermal diffusion constant, $\langle Dv \rangle$, is normally determined by integral methods, namely by investigating the relaxation of the neutron density in time or in space. In this work a different approach was used by measuring the differential scattering cross section $d\delta(\theta)/d\Omega$, for different neutron energies, E, and sample temperatures, T. From the functions, $d\delta/d\Omega$, the diffusion constant, D (E, T), and $\langle Dv \rangle$, can be calculated. It was found that the scattering cross sections, $d\delta/d\Omega$, are very insensitive to the temperature. Therefore, the quantity $\langle Dv \rangle$ can be calculated within a large temperature range by means of a comparatively small number of $d\delta/d\Omega$ measurements. Good agreement between these $\langle Dv \rangle$-data and the more conventional experiments was observed for H_2O and D_2O. (auth)

37114 (AFCRL-64-496) INVESTIGATION OF CHEMICAL KINETICS OF ATMOSPHERIC DEIONIZATION. Final Report. M. H. Bortner and V. D. Povard (General Electric Co. Missile and Space Div., Valley Forge Space Technology Center, King of Prussia, Penna.). Mar. 1964. Contract AF19(604)-8820. 67p.

A program was carried out to determine the rate constants of the reactions occurring during the deionization of a highly ionized atmosphere. The program included an analysis of the chemical reactions, theoretical calculations of the rate constants for the reactions $O^+ + O^- \rightarrow 2\ O$ and $N^+ + O^- \rightarrow N + O$, and an experimental study of the dissociative recombination of NO^+. (D.L.C.)

37115 (ANL-6856) A SEMINAR ON GROUPS V AND VI ANIONS, HELD AT ARGONNE NATIONAL LABORATORY, FEBRUARY 26 AND 27, 1964. R. J. Beals, J. H. Handwerk, and J. F. Schumar, comps. (Argonne National Lab., Ill.). Mar. 1964. Contract W-31-109-eng-38. 53p.

A total of 21 brief papers are presented on thermodynamic properties, structure, phase relations, mechanical properties, transport properties, and magnetic properties of various nitrides, phosphides, arsenides, antimonides, sulfides, selenides, and tellurides. (D.L.C.)

37116 (JPRS-25741(p.52-7)) STUDY OF TRIVALENT RARE EARTH OXIDES–BERYLLIUM OXIDE SYSTEM. II. THE ACTIVITY OF BeO AND THE STRUCTURAL MODEL OF THE MELT IN La_2O_3–BeO SYSTEM ENRICHED WITH BeO MELT. Chu-kun Kuo and Tung-sheng Yen. Translated from K'o Hsueh T'ung Pao, No. 5, 457-8(May 1964).

The observed melting point-composition graph of BeO in the BeO–La_2O_3 system is compared with those calculated from the lowering of the melting point of a solvent in a solution. The calculations for the reaction $La_2O_3 + 2\ BeO \rightarrow 2\ La^{3+}\ Be_2O_5^{6-}$ give results close to, but still higher than, the experimental data. A search was made for a further reaction of complex ions with BeO, and it was found that the equilibrium $2\ Be_2O_5^{6-} + 2\ BeO \rightleftharpoons 3\ Be_2O_4^{4-}$ fits the experimental curve very well. (D.L.C.)

37117 (JPRS-25741(p.187-90)) THE STUDY OF TRIVALENT RARE EARTH OXIDES–BERYLLIUM OXIDE SYSTEM. I. PHASE EQUILIBRIUM OF La_2O_3–BeO SYSTEM. Chu-kun Kuo and Tung-sheng Yen. Translated from K'o Hsueh T'ung Pao, No. 5, 455-6(May 1964).

The phase equilibrium relationships of the BeO–La_2O_3 system at 1250 to 2200°C were studied using hardening, microscopic, and x-ray methods. The results are presented in a phase diagram. Two compounds were found, $La_2O_3 \cdot 2\ BeO$ and $3\ La_2O_3 \cdot 2\ BeO$, and their structures were determined. The bonds and stability of the compounds are discussed. (D.L.C.)

37118 ISOTOPE EFFECTS IN ELECTROCHEMICAL PROTON DISCHARGE. B. E. Conway and M. Salomon (Univ. of Ottawa). Ber. Bunsenges. Physik. Chem., 68: 331-40(1964).

The H/D and H/T separation factors (S) and the exchange current density ratios (R) were calculated for the proton discharge mechanism on Hg, Fe, and Ni. A vibrational analysis of the activated complexes was made by reference to both a linear three-center transition state model and a surface interstitial site model in which H was regarded as being adsorbed adjacent to two metal atoms in the surface. It is shown that the isotope effect observed experimentally, e.g. on mercury, can be accounted for in terms of a slow proton discharge mechanism. Calculations were made for the discharge from H_3O^+ and H_2O molecules. The values of R are shown to be consistent with the experimental and calculated values of S_D. A qualitative explanation is also given for the potential dependence of S_D on Hg in terms of electrostriction effects in the double layer. (auth)

37119 THE SPECIFIC HEAT OF SOME URANIUM AND THORIUM CARBIDES BETWEEN 1.8°K AND 4.2°K. J. B. Harness, J. C. Matthews, and N. Morton (Univ. of Nottingham, Eng.). Brit. J. Appl. Phys., 15: 963-6(Aug. 1964).

Uranium carbide (UC), thorium carbide (ThC) and UC–ThC solid solutions exhibit temperature variations of specific heat in the helium temperature range which are characteristic of metals. The form of the common rigid energy band of UC and UC–ThC mixed carbides was determined between the Fermi limits of UC and of UC–15% ThC. (auth)

37120 ON THE MECHANISM OF ZIRCONIUM DISSOLUTION IN ACID FLUORIDE SOLUTIONS. V. A. Gil'man and Ya. M. Kolotyrkin (Karpov Inst. of Physics and Chemistry, Moscow). Dokl. Akad. Nauk SSSR, 155: 1155-8(Apr. 11, 1964). (In Russian)

The mechanism of zirconium dissolution in HF (0.1N H_2SO_4 + 0.01N HF) solutions, considering the kinetics of Zr transition into the solution and separation of hydrogen, was investigated. The rate of the processes was also studied as a function of zirconium potential. (R.V.J.)

37121 MAGNETIC RELAXATION OF PROTONS AND DEUTERONS IN AQUEOUS SOLUTIONS OF Cr^{3+} IONS. R. K. Mazitov (Kazan State Univ., USSR). Dokl. Akad. Nauk SSSR, 156: 135-8(May-June, 1964). (In Russian)

It was found previously that the nuclear magnetic relaxation time of protons in aqueous $CrCl_3$ solutions is shortened if the solution is heated; this phenomenon was attributed to the decrease of the time of residence of the protons in the first hydrate shell of the Cr^{3+} ion. In view of the known differences in the chemical exchange rates of protons and deuterons, this problem was investigated by determining the magnetic relaxation times of H and D in Cr^{3+} solutions as a function of the temperature and the isotopic composition of the water. The proton resonance was determined at a frequency of 28.7 Mc, that of the deuteron at 4.4 Mc, at a constant magnetic field of 6730 oersted. $Cr(NO_3)_3$ and heavy water containing 99.5% D was used for the measurements. A differential behavior was noted in the temperature dependence of the relaxation time. The density of uncoupled electrons was found to be lower at D than at H locations, confirming the previous observation with aqueous Mn^{2+} solutions. In studying the effect of the isotopic composition of the water at 0°C, it was found that the relaxation times of H became longer as D_2O is added, while the corresponding D times were not affected noticeably. A slight (30%) increase was noted in the H relaxation times upon addition of D_2O at room temperature. (TTT)

37122 PHASE EQUILIBRIA IN THE $UO_2SO_4-H_2O-$BEDBP AND THE $H_2SO_4-H_2O-$BEDBP (DIBUTYL ETHER DIBUTYL PHOSPHINE) SYSTEMS. A. V. Nikolaev, I. M. Ivanov, and I. I. Yakovlev (Inst. of Inorganic Chemistry, Academy of Sciences, Siberian SSR). Dokl. Akad. Nauk SSSR, 156: 888-90(June 1, 1964). (In Russian)

A detailed phase diagram is given for the $UO_2SO_4-H_2O-$BEDBP system. The phase diagram shows a narrow region of equilibrium between the aqueous and organic solutions of uranyl sulfate. Then, since the compound $UO_2SO_4 \cdot$ 2BEDBP is poorly soluble in water there is a rather wide invariant region consisting of the solid dissolvate, an organic phase, and an aqueous phase. Then, there is a region of equilibrium of the solid dissolvate with the aqueous phase, a region of equilibrium of the solid dissolvate, the trihydrate and a saturated aqueous solution, and finally, a region where the solid dissolvate is in equilibrium with a saturated organic phase. A solubility diagram is presented for the $H_2SO_4-H_2O-$BEDBP system at 25°C [BEDBP is dibutyl ether dibutyl phosphine or $C_4H_9OPO(C_4H_9)_2$]. BEDBP is a more powerful extractant than tributylphosphate [TBP or $(C_4H_9O)_3PO$]. (TTT)

37123 THE EXCHANGEABILITY OF HYDROXYL GROUPS IN KAOLINITE. E. Halevy (Weizmann Inst. of Science, Rehovoth, Israel). Geochim. Cosmochim. Acta, 28: 1139-45(July 1964).

HTO and $H_2^{18}O$ were used to investigate the isotopic exchange of hydroxyl groups in kaolinite. The per cent exchange of surface hydroxyls was found to be small (<1%), but enough to account for a possible mechanism of anion exchange of a few milliequivalents per 100 g. (auth)

37124 VARIATION OF VISCOSITY WITH TEMPERATURE IN HEAVY WATER. R. C. Bhandari and M. L. Sisodia (Univ. of Rajasthan, Jaipur, India). Indian J. Pure Appl. Phys., 2: 266-7(Aug. 1964).

An expression was derived for the temperature variation of the viscosity (η) of heavy water in the temperature range 20–280°C., namely $\eta = A. \exp (B/T - T_0)$ where A = 302 μP, B = 537.5°K, and T_0 = 150°K. The activation energy (E = R × B) for viscous flow, which is independent of temperature, was found to be 1075 cal/mole. It was shown that the interpretation of temperature variation of viscosity in heavy water, based on the concepts of free volume, agrees with that in the case of ordinary water, suggesting that heavy water may have the same structural model (except that hydrogen is replaced by deuterium) as proposed by G. Nemethy and H. A. Scheraga for ordinary water. (auth)

37125 ISOTOPIC EFFECT IN ELECTROCHEMICAL REDUCTION OF NITRIC ACID TO AMMONIA. I. A. Tikhomirov (Tomsk Polytechnik Inst., USSR). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 3, Ser. Khim. Nauk, No. 1, 21-5 (1964). (In Russian)

The reduction was carried out in a glass electrolytic cell with continuous solution circulation at different temperatures, current densities, and circuits. The anode was a Pt mesh and the cathode a Cu spiral. The electrolyte was a mixture of 1.4 N HNO_3 and 2.1 N H_2SO_4. The ratio of $^{14}N^{14}N$ to $^{14}N^{15}N$ was determined by mass spectrography. The heavy isotope accumulated in the residue of acid not converted to ammonia. The enrichment was independent of the ratio of the residual amount of acid to the initial. With increasing temperature from 10 to 40°C the enrichment increased rapidly, and then decreased gradually with further increase to 60°C. The overall reaction is $HNO_3 + 8H^+ + 8e = NH_3 + 3H_2O$. Intermediate products are adsorbed on the cathode, which catalyzes their further reaction. (IIC-MG)

37126 FUSION DIAGRAM OF ScF_3-NaF SYSTEM. N. Ya. Fedorov, S. I. Sklyarenko, and E. S. Petrov (Chemico-Metallurgical Inst., Novosibirsk, USSR). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 3, Ser. Khim. Nauk, No. 1, 104-7(1964). (In Russian)

The fusibility diagram of the ScF_3-NaF system was studied by thermal analysis with automatic temperature recording in the composition range 0 to 50% ScF_3. For compositions containing >50% ScF_3, only the eutectic line was determined. Up to 50% ScF_3, two chemical compounds were formed: Na_3ScF_6, which melts incongruently in a peritectic reaction at 825°C, and Na_2ScF_5, which melts congruently at 886°C. At 660°C, Na_3ScF_6 undergoes a phase transformation, the nature of which was not established. (tr-auth)

37127 HYPERFINE STRUCTURE IN THE MICROWAVE SPECTRUM OF NH_2D. P. Thaddeus (Columbia Univ., New York and Goddard Inst. for Space Studies, New York), L. C. Krisher, and P. Cahill. J. Chem. Phys., 41: 1542-7(Sept. 15, 1964).

Hyperfine structure in the $3_{13} \rightarrow 3_{03}$ rotation–inversion transition of deuterated ammonia NH_2D at 18 807.7 Mc/sec was studied with a beam maser microwave spectrometer giving a linewidth of 7 kc/sec. All details of the observed hyperfine structure were accounted for in terms of the various quadrupole, spin–rotation, and spin–spin interactions of the four coupling nuclei. The hyperfine coupling constants, which were determined with the aid of a digital electronic computer are, for the 3_{13} state: $(eq_jQ)_D = -62.5 \pm 1.0$ kc/sec, $C_D = -2.7 \pm 0.3$ kc/sec, $C_H = -13.6 \pm 0.5$ kc/sec; and for the 3_{03} state: $(eq_jQ)_D = -73.9 \pm 1.0$ kc/sec,

$C_D = -2.7 \pm 0.3$ kc/sec, $C_H = -12.3 \pm 0.5$ kc/sec. On the assumption that the electric field at the deuteron is cylindrically symmetric about the N–D bond direction ξ, it was found that $(eV_{\xi\xi}Q)_D = 282 \pm 12$ kc/sec, or $V_{\xi\xi} = 1.38 \pm 0.06 \times 10^{15}$ stat V/cm^2, where $V_{\xi\xi}$ is the second derivative of the electrostatic potential along ξ. (auth)

37128 THERMODYNAMIC FUNCTIONS OF MORSE OSCILLATORS. Roger W. Crecely and David J. Wilson (Univ. of Rochester, N. Y.). J. Chem. Phys., 41: 1564-7 (Sept. 15, 1964).

Partition functions and thermodynamic functions were calculated for one-dimensional classical and quantal Morse and harmonic oscillators to investigate anharmonic and quantal effects. Results are shown graphically for oscillators corresponding to H_2, D_2, and N_2; results on Br_2 are described briefly. (auth)

37129 RELATIVE RATES OF REACTION OF BROMINE ATOMS WITH ISOTOPIC HYDROGEN MOLECULES. Richard B. Timmons and Ralph E. Weston, Jr. (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 41: 1654-61(Sept. 15, 1964). (BNL-7946)

Kinetic isotope effects in the reaction of bromine atoms with isotopic hydrogen molecules were measured. Rate constant ratios were determined by isotopic analysis of H_2–HD, H_2–HT, or H_2–D_2 mixtures before and after reaction with bromine atoms. Over the temperature range of 438 to 623°K, the ratios of the second-order rate constants were $k_{H_2}/\Sigma k_{HD} = (1.14 \pm 0.01) \exp (591 \pm 4/RT)$, $k_{H_2}/\Sigma k_{HT} = (1.22 \pm 0.02) \exp (658 \pm 16/RT)$, $k_{H_2}/k_{D_2} = (1.32 \pm 0.04) \exp (1253 \pm 37/RT)$. A comparison of these results with the corresponding isotope effects obtained in the chlorine- and iodine-atom experiments reveals surprisingly little difference in kinetic isotope effects. The theoretical calculation of the kinetic isotope effects was carried out using Bigeleisen's theory of isotope effects on reaction rates. The calculations were made using various methods of constructing the potential energy surface and it was found that none of the semiempirical methods used gave agreement to better than 40 to 80%. (auth)

37130 EFFECT OF PRESSURE ON EMISSION AND ABSORPTION SPECTRA OF ALKALI HALIDE PHOSPHORS. P. B. Alers and P. E. V. Shannon (Naval Research Lab., Washington, D. C.). J. Chem. Phys., 41: 1675-8(Sept. 15, 1964).

Absorption and emission energies of certain alkali halide phosphors under pressure were measured. The systems involved were KCl:Tl, NaCl:Tl, KCl:Pb, NaCl:Pb, CsI:Tl, and NaI:Tl, and pressures in excess of 40 kbar were employed. Data for NaCl:Tl and the low- and high-pressure forms of KCl:Tl could be fitted by a configuration coordinate model, but the behavior of the other systems could not be described in this way. (auth)

37131 INFRARED SPECTRUM OF CYANOGEN-$^{15}N_2$ AND INTERMOLECULAR COUPLING IN THE CRYSTAL. Eugene R. Nixon (Univ. of Pennsylvania, Philadelphia) and Frank D. Verderame. J. Chem. Phys., 41: 1682-7(Sept. 15, 1964).

The infrared spectrum of cyanogen-$^{15}N_2$ is reported for the gas at room temperature and for the polycrystalline film at 80°K over the range 500–4000 cm^{-1}. Davydov splittings in the ν_3 fundamental are discussed in terms of 6–12 intermolecular potentials and also in terms of the intermolecular coupling of mutually polarizable dipoles. Calculated splittings and intensities are given for various assumed crystallite sizes and shapes. (auth)

37132 ELECTRICALLY INDUCED PERTURBATIONS OF HALOGEN NUCLEAR QUADRUPOLE INTERACTIONS IN POLYCRYSTALLINE COMPOUNDS. I. PHENOMENOLOGICAL THEORY AND EXPERIMENTAL RESULTS. R. W. Dixon and N. Bloembergen (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 41: 1720-38(Sept. 15, 1964).

When a nucleus in a dielectric solid occupies a lattice site that lacks inversion symmetry, the application of an external electric field causes a change in the electric field gradient at this nucleus. The magnitude of the change is proportional to the applied field. When the nucleus has spin greater than one-half and possesses a nonzero quadrupole moment, the quadrupole interaction energy is, therefore, a linear function of the applied field. This field gradient perturbation is discussed phenomenologically through the use of a third rank tensor R, which relates the electric field and the electric field gradient via the equation $e\Delta q = R \cdot E$. Changes in the quadrupole interaction energy, observed as broadenings of nuclear quadrupole resonance lines in zero magnetic field, were obtained for ^{35}Cl, ^{81}Br, and ^{127}I nuclei in halogenated polycrystalline compounds including several halogenated methanes and benzenes, the solid halogens, and iodic acid. Broadened line shapes, local electric field corrections, and restrictions imposed by nuclear site symmetries are discussed. All observations are consistent with the phenomenological theory. (auth)

37133 ELECTRICALLY INDUCED PERTURBATIONS OF HALOGEN NUCLEAR QUADRUPOLE INTERACTIONS IN POLYCRYSTALLINE COMPOUNDS. II. MICROSCOPIC THEORY. R. W. Dixon and N. Bloembergen (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 41: 1739-47(Sept. 15, 1964).

The physical origins of electrically induced perturbations of quadrupole couplings in molecular solids are considered. Experiment and elementary theory are compared and it was concluded that polarizations of bonding electrons near the resonant nuclei are of dominant importance in determining the magnitudes of the electrically induced shifts. (auth)

37134 INTRAMOLECULAR ISOTOPE EFFECTS IN THE HD-RARE GAS ION-MOLECULE REACTIONS. Fritz S. Klein and Lewis Friedman (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 41: 1789-98(Sept. 15, 1964). (BNL-7952)

The ion–molecule reactions of HD^+–He, HD^+–Ne, Ar^+–HD, and Kr^+–HD were studied and the intramolecular isotope effects determined over a range of kinetic energies of the reactant ion. The intramolecular isotope effects were found to vary with ion kinetic energy transfer to internal degrees of freedom in the reaction products. Three types of isotope effects are proposed to account for experimental data. An atom or ion transfer mechanism, which gives rise to a higher probability of formation of XH^+ over XD^+, is the dominant factor at high ion kinetic energies. At low energies the unimolecular decomposition of a triatomic intermediate is assumed to form preferentially XD^+. For the HD^+–He and HD^+–Ne reactions evidence is obtained indicating dissociation of the ionic product with an associated isotope effect favoring the XH^+. (auth)

37135 DEUTERIUM-ISOTOPE EFFECT IN THE CHLORINE EXCHANGE BETWEEN HYDROGEN CHLORIDE AND CHLORINE ATOMS. A STUDY OF MODELS FOR THE TUNNEL EFFECT. Fritz S. Klein (Weizmann Inst. of Science, Rehovoth, Israel), Avigdor Persky, and

Ralph E. Weston, Jr. J. Chem. Phys., 41: 1799-1807 (Sept. 15, 1964). (BNL-7972)

The rates of the exchange reactions of chlorine atoms with hydrogen chloride and with deuterium chloride were measured as a function of temperature. Chlorine atoms were produced by photodecomposition of chlorine gas and their relative concentration was monitored by their reaction with deuterium: $Cl + D_2 \rightarrow DCl + D$. The temperature dependence of the logarithm of the ratio of rates was found to be nonlinear in the temperature range of 30 to 150°C. Various attempts to calculate the isotope effect assuming different types of tunneling are discussed. (auth)

37136 PARAMAGNETIC RESONANCE OF SOME S-STATE IONS IN SINGLE CRYSTALS OF STRONTIUM OXIDE. Alexander J. Shuskus (United Aircraft Research Labs., East Hartford, Conn.). J. Chem. Phys., 41: 1885-6(Sept. 15, 1964).

Paramagnetic resonance measurements at X band were carried out on single crystals of cubic strontium oxide in which the S-state ions Mn^{2+}, Eu^{2+}, and Gd^{3+} were introduced as impurities. The spectra are discussed, and spin Hamiltonian parameters are tabulated. (P.C.H.)

37137 POLAROGRAPHY IN MOLTEN SALTS. H. C. Gaur and R. S. Sethi (Univ. of Delhi). J. Electroanal. Chem., 7: 474-86(June 1964).

Developments in the application of the polarographic method to the study of molten salt solutions are reviewed. The scope of the review has been extended to include the progress in methods of solvent preparation, fabrication of the indicator electrodes, and development of depolarized reference systems also. 100 references are included. (P.C.H.)

37138 COLLOQUE INTERNATIONAL DE DIFFUSION ET DIFFRACTION NEUTRONIQUES, GRENOBLE, DU 3 AU 5 SEPTEMBRE 1963. (International Colloquium on Neutron Scattering and Diffraction, Grenoble, September 3-5, 1963). J. Phys., 25: 425-660(May 1964). (CONF-232)

The topics discussed included neutron diffraction studies of crystal structure of oxides, hydrides, fluorides, chlorides, and oxyhydrates, instrumentation, magnetic structures of spinels and other oxides and oxyhydrates, halogens, metals, and alloys, anomalous dispersion, magnon scattering, and phonon scattering. Separate abstracts are prepared for 16 of the 49 papers presented. Abstracts of 6 papers previously appeared in *NSA* (17: 39714, and 18: 1599, 21131, 26498, 27973, and 35495). (C.E.S.)

For abstracts of individual papers see: 37139, 37140, 37141, 37142, 37143, 37144, 37145, 37146, 37147, 37148, 37149, 37150, 37151, 37527, 37710, and 37711.

37139 STRUCTURES OF UO_2, UO_{2+x} AND U_4O_9 BY NEUTRON DIFFRACTION. B. T. M. Willis (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Phys., 25: 431-9(May 1964).

Single crystals were examined by neutron diffraction in the range of temperatures 20 to 1100°C and of compositions UO_2 to U_4O_9. The investigations divide into three groups, relating to UO_2, UO_{2+x} (where $0 < x < 0.25$) and U_4O_9. The UO_2 has the fluorite structure at room temperature, with isotropic Debye-Waller factors. At high temperatures the atomic arrangement can no longer be described exactly in terms of the ideal fluorite structure with harmonic thermal vibrations. Better agreement between observed and calculated intensities is obtained by allowing the oxygen atoms to relax to positions with coordinates $\frac{1}{4} + \delta$, $\frac{1}{4} + \delta$, $\frac{1}{4} + \delta$ ... in the Fm3m space group, where δ is 0.016 at 1000°C. The relaxation effect can be interpreted in terms of either disorder or anharmonic thermal motion. On oxidizing UO_2 to UO_{2+x} a solid solution is formed, containing three kinds of oxygen atom, O, O′ and O″. The O atoms occupy the fluorite-type sites of UO_2, but a proportion of these sites is empty in UO_{2+x}. The O′ and O″ atoms occupy interstitial positions, which are displaced along ⟨110⟩ (for O′) and along ⟨111⟩ (for O″) from the large interstices in the fluorite structure. The interstices themselves are not occupied. At the composition $UO_{2.25}$ the oxygen atoms are ordered to form the new phase U_4O_9. The main neutron reflections of U_4O_9, corresponding to the fluorite-type peaks of UO_2, are much stronger than the superlattice reflections, which arise from the ordering of the interstitial oxygen atoms within the fluorite framework. The analysis of the intensities of the main reflections shows that there are two kinds of interstitial sites, as in UO_{2+x}: the O′ atoms are located 0.85 Å along the ⟨110⟩ directions from the centers of the large interstices, and the O″ atoms 1.05 Å along ⟨111⟩. Vacancies occur in the fluorite-type oxygen sites (O) but not in the uranium sites, and the chemical formula $UO_{2.25}$ is expressed more fully as $U_{1.00}\,O_{1.77}\,O'_{0.29}\,O''_{0.19}$. It is concluded that oxygen atoms cannot enter the fluorite structure individually but are incorporated in small groups containing O′ and O″ atoms and O vacancies. A complete structure determination of U_4O_9 must await the analysis of the superlattice reflections. (auth)

37140 NEUTRON DIFFRACTION STUDY OF NICKEL ZIRCONIUM HYDRIDE. S. W. Peterson (Washington State Univ., Pullman), V. N. Sadana, and W. L. Korst. J. Phys., 25: 451-3(May 1964).

Neutron diffraction studies were carried out on powder samples of $NiZrH_3$ and $NiZrD_3$. The x-ray space group and heavy atom positions are confirmed. Hydrogen atoms are located in 4 fold and 8 fold positions of the orthorhombic space group Cmcm. The 8 fold hydrogen atoms have three Zr and one Ni close neighbor while the 4 fold hydrogen atoms have an approximate five-fold coordination. (auth)

37141 THE STRUCTURE OF HoD_3. M. Mansmann and W. E. Wallace (Univ. of Pittsburgh). J. Phys., 25: 454-9 (May 1964).

An attempt was made to provide information concerning the location of the deuterium ions in the hexagonal trideuterides. HoD_3 was chosen for study and neutron powder diffraction patterns were obtained using the test reactor. The unit cell found for HoD_3 using neutrons is three times larger than the pseudo-cell found using x-ray procedures ($a_n = 6.308$ Å, $c_n = 6.560$ Å). Thus the unit cell contains 6 holmium and 18 deuterium ions. The space group for HoD_3 is $P\bar{3}c1$ (D^4_{3d}). The occupancy of positions is given. The trihydrides of the following metals have the same x-ray pseudo cell: Sm, Gd, Tb, Dy, Ho, Er, Tm, Lu, and Y. From general considerations it appears that these hydrides are isostructural with HoD_3. (auth)

37142 NEUTRON DIFFRACTION AND SCATTERING STUDIES AT J.A.E.R.I. N. Kunitomi, Y. Hamaguchi, M. Sakamoto, K. Doi, and S. Komura (Japan Atomic Energy Research Inst., Tokyo). J. Phys., 25: 462-8(May 1964).

The neutron diffraction and scattering studies performed from 1962 to 1963 are briefly described. Reflectivity of the collimated neutrons from a mosaic crystal: A calculation similar to Bacon and Lowde's theory, taking secondary extinction into account, was carried out including the effect of neutron collimation. The theoretical results imply that

the reflectivity decreases with increasing collimation. These results are compared with experiment. Crystal structure of UF_4: In a series of investigations on actinide elements, the positions of fluorine were determined by means of powder diffraction techniques. The diffraction lines are compared with the x-ray diffraction pattern, and the most plausible model is determined by comparing the experimental intensity with the theoretical one deduced from geometrical considerations. The uranium–fluorine distance derived from a radial Fourier analysis is proved to be consistent with the model. Scattering of neutrons from hydrides: The transmissivity of neutrons through TiH_{2-x} was investigated as a function of hydrogen concentration and temperature. Although the experimental temperature exceeds the cubic-tetragonal transformation temperature, no remarkable change was observed indicating the constancy of the Einstein frequency of the optical branch throughout the experimental temperature range. Magnetic structure of Mn-Cr: Electric resistivity and magnetic susceptibility measurements and neutron diffraction studies were made on Mn-Cr alloys. The results show that these alloys are antiferromagnetic and suggest the magnetic properties of these alloys to be interpreted in terms of band theory. (auth)

37143 RECENT CRYSTAL STRUCTURE DETERMINATIONS BY NEUTRON DIFFRACTION AT OAK RIDGE. George M. Brown and Henri A. Levy (Oak Ridge National Lab., Tenn.). J. Phys., 25: 469-73(May 1964).

Crystal structures were determined from three-dimensional neutron data for xenon difluoride, xenon tetrafluoride, barium chloride dihydrate, potassium heptafluoniobate, chloral hydrate, sucrose, and strontium hydroxide octahydrate. Data were taken on the automatic three-circle neutron diffractometer. Refinements, by the method of least squares, yielded structural parameters of high precision. (auth)

37144 ON SYMMETRICAL O–H–O HYDROGEN BONDS. R. E. Rundle (Ames Lab., Ames, Iowa). J. Phys., 25: 487-92(May 1964). (IS-709)

Several hydrogen bonds with O–H–O bond lengths of about 2.4 Å are now known. Some of these were examined well enough by neutron diffraction and other means to know with reasonable certainty that they are symmetrical hydrogen bonds, with either a single or a symmetrical double distribution peak. Even neutron diffraction results remain ambiguous as to whether the distribution has a single or double maximum. Several investigators have reported crystallographically symmetrical O–H–O hydrogen bonds with distances of about 2.5–2.6 Å. Thermal amplitudes of some of these were given careful study, and most of these longer bonds appear to be truly, not statistically, symmetrical. It seems likely that the bonds of about 2.4 Å are distributions with single maxima, while the longer, apparently symmetrical hydrogen bonds are cases of double maxima. IR and NMR evidence that there are O–H–O bonds as long as 2.6 Å with single maxima should be carefully checked before they are accepted. From some theoretical calculation of hydrogen distributions in double and single wells it can be shown that cases with double maxima have a strong isotope effect with a shorter O–H–O distance than O–D–O distance, while cases with single maxima should show almost no isotope effect. With present accuracy in structure determinations a distinction between the two cases seems possible with or without the use of neutron diffraction. As an example that bond distances reliable to ~0.01 Å are now obtainable in nearly routine fashion, the structure of 3,4-furandicarboxylic acid was determined to about this accuracy with data obtained in ten days. (auth)

37145 A POSSIBLE USE OF ABSORPTION FILTERS IN NEUTRON DIFFRACTION. M. Domenici (SORIN, Saluggia, Vercelli, Italy). J. Phys., 25: 493-4(May 1964). (In French)

A filter is described which allows the higher harmonics of a monochromatic neutron beam to be separated. With the aid of this filter one can obtain a very small wavelength which represents the only possibility, with certain apparatus, of exploring the high angle region. (auth)

37146 PROBLEMS AND PROCEDURES IN COLLECTION OF THREE-DIMENSIONAL NEUTRON-DIFFRACTION DATA FOR CRYSTAL STRUCTURE DETERMINATION. George M. Brown and Henri A. Levy (Oak Ridge National Lab., Tenn.). J. Phys., 25: 497-502(May 1964).

Three-dimensional neutron-diffraction data were collected for crystals of thirteen different compounds on the automatic three-circle neutron diffractometer. Problems and procedures in data collection are discussed, from selection of crystals through data processing. Precision of measurements on the instruments is also discussed. (auth)

37147 NEUTRON DIFFRACTION STUDIES AT LIVERMORE. J. T. Sparks and T. Komoto (Univ. of California, Livermore). J. Phys., 25: 567(May 1964). (In French)

Neutron diffraction studies of CrS, NiS, and $Fe_{0.902}S$ are described. (auth)

37148 ANOMALOUS DISPERSION OF SLOW NEUTRONS IN CRYSTALS. H. G. Smith and S. W. Peterson (Oak Ridge National Lab., Tenn.). J. Phys., 25: 615-17 (May 1964).

Studies of anomalous scattering of neutrons from CdI_2 single crystals were continued over an energy range including the cadmium resonance peak at 0.178 ev. The complete (h 0 l) zone of reflections was measured at one wavelength (1.075 Å) in order to permit a structure refinement which would simultaneously give a precise measurement of the complex scattering amplitude of cadmium at this wavelength. Selected reflections were also measured at several other wavelengths. In addition, a single crystal of $^{113}CdI_2$ was grown, and Bragg intensities were measured for several reflections at 1.075 Å. A complete least-squares refinement of the (h 0 l) zone was computed which included anisotropic thermal parameters as well as the complex scattering amplitude of cadmium. The latter is in remarkably good agreement with that calculated with the aid of the Breit-Wigner single level formulation using the neutron and gamma widths determined for cadmium by Brockhouse. (auth)

37149 CRITICAL NEUTRON SCATTERING. Jacques Villain (CEN, Saclay, France). J. Phys., 25: 618-26(May 1964). (In French)

The neutron scattering cross section of magnetic samples becomes very large near the critical point because of the occurrence of important fluctuations of magnetization. The critical cross section is shown to be proportional to the susceptibility in a static sinusoidal magnetic field, which can be calculated approximately. The scattering tends to become elastic when T approaches the critical temperature and when the scattering vector tends to a reciprocal lattice point (in a ferromagnet) or to a superlattice point (in an antiferromagnet) because the relaxation of the fluctuations is then forbidden by thermodynamic (and, in a ferromagnet, kinematic) causes. The theory of the inelasticity of the

quasi-critical scattering does not seem to agree with experiment. This may be due to the fact that this theory is based upon ill-justified assumptions. (auth)

37150 REMARKS ON THE SLOW NEUTRON SCATTERING BY ORGANIC MOLECULES. V. Ardente (CCR Euratom, Ispra, Italy). J. Phys., 25: 641-7(May 1964).

In the framework of the interaction of a neutron with molecular nuclei and with a special view to organic molecules (polyphenyls), a preliminary analysis is made on the scattering by bound protons in the benzene molecule (this molecule is assumed to be a fundamental dynamic unit). In evaluating the effect of the molecular dynamics on the scattering of thermal neutrons, several physical hypotheses were tried. The main purpose of these assumptions is to enable one, when considering explicitly the dynamics of the proton, to investigate both the influence of the different individual features of the molecular dynamics and the effect of different mathematical approximations on the explicit consideration of such dynamical features. This was performed with reference to experimental results both on integral quantities (e.g. the total scattering cross section) and on differential ones. In the framework of the gas model the effect of a single structure parameter, namely the effective mass Mo, was investigated. A molecular gas was considered by introducing two parameters (Krieger-Nelkin): one, of the effective mass Mo type, accounting for rotations and translations and a second one formally taking into account the elastic vibrational transitions from the ground state. The possibility is discussed of calculating the best fitted value of the parameter Mo from experimental data, the value of the vibrational parameter being determined once the frequency distribution of the proton in the molecule is known. The particular structure of this vibrational spectrum induced a discussion of a two-vibrational model in analogy to the Nelkin model for the H_2O molecule, where, in the explicit consideration of the various degrees of freedom, the complicated vibrational spectrum was replaced by an isotropic, very simplified one. The purely vibrational features (still in the frame of the harmonic approximation was treated by considering explicitly the anisotropy of the vibrational spectrum and evaluating in a more correct way the relation of the molecular orientations. The rotational and translational degrees of freedom were neglected; these will be appropriately introduced by means of a correction in the vibrational spectrum in the low energy region. A comparison was made between this analysis, which — in the framework of an analogy with a polycrystalline assembly of graphite microcrystals — adopts the formalism of Schofield and Hassitt and the set of more refined and mathematically more correct assumptions contained in the Summit code which translates the Parks' viewpoint. (auth)

37151 DETERMINATION BY COLD-NEUTRON SCATTERING OF THE PROTON FREQUENCY SPECTRA IN ORTHO-, PARA-, AND METAXYLENE. W. Van Dingenen and S. Hautecler (CEN, Mol, Belg.). J. Phys., 25: 648-53 (May 1964). (In French)

Measurements by J. J. Rush by means of cold neutrons showed energy differences in the total cross sections of the compounds ortho-, para- and meta-xylene. By a time-of-flight method the energy spectrum of the scattered neutrons is determined. The beam of a cold neutron source is quasi-monochromatized by means of a Be-filter and the energy spectrum is obtained by the association of a chopper with a 100 channel time selector. The results are compared for the three substances and the frequency spectra, and total cross sections obtained by J. J. Rush are compared in order to find a correlation. (auth)

37152 THE EFFECT OF DEUTERIUM ON THE LUMINESCENCE DECAY TIMES OF SOLVATED RARE EARTH CHLORIDES. J. J. Freeman (Univ. of New Mexico, Albuquerque), G. A. Crosby, and K. E. Lawson. J. Mol. Spectry., 13: 399-406(Aug. 1964). (SC-DC-3509)

The decay times of the luminescence obtained from crystals of $TbCl_3$ and $EuCl_3$ solvated with H_2O and D_2O were measured. It was found that the lifetimes of the metal ions solvated with D_2O were substantially longer than the lifetimes of the ions solvated with H_2O. The significant increase in the observed mean decay times is attributed to a decrease in radiationless deactivation of the excited states of the rare earth ions brought about by the substitution of D_2O for H_2O in the crystal lattices. (auth)

37153 ELECTRONIC STRUCTURES OF KRYPTATES AND XENATES. D. S. Urch (London Univ.). Nature, 203: 403-4(July 25, 1964).

The electronic structures of kryptates and xenates are discussed. The models considered are based on regular octahedra and tetrahedra. This is reasonable only if the 4s (Kr) and 5s (Xe) orbitals are so tightly bound that they have no stereochemical effect. Since the formation of these anions depends on the s orbitals being tightly bound this does not seem too extreme an assumption. (P.C.H.)

37154 THE TEMPERATURE VARIATION OF ELECTRONIC MOBILITY IN RUTILE (TiO_2) AND α-Nb_2O_5 AT ELEVATED TEMPERATURES. J. Yahia (Pennsylvania State Univ., University Park). J. Phys. Chem. Solids, 25: 881-7(Aug. 1964).

It is pointed out that thermogravimetric and electric conductivity data in combination afford a method of determining mobility at elevated temperatures in low mobility semiconductors. The temperature variation of the electronic mobility calculated using this method is presented for rutile in the range 860–1050°C and for α-Nb_2O_5 in the range 900–1400°C. The mobility for both substances is low, $\sim 5 \times 10^{-5}$ cm^2/v-sec at 1200°K for rutile and $\sim 7 \times 10^{-2}$ cm^2/v-sec for α-Nb_2O_5 at the same temperature; further, the mobility increases with an increase in temperature for both materials. An analysis of these results in terms of self-trapping of the charge carrier (giving rise to a diffusion mode of motion) is also presented. (auth)

37155 MAGNETIC HYPERFINE INTERACTIONS AND RELAXATION PHENOMENA IN PARAMAGNETIC Dy_2O_3. S. Ofer (Hebrew Univ., Jerusalem), B. Khurgin, M. Rakavy, and I. Nowik. Phys. Letters, 11: 205-6(Aug. 1, 1964).

Magnetic hyperfine splittings were observed in the recoilless absorption of the 26-kev gamma rays from ^{161}Dy in paramagnetic polycrystalline Dy_2O_3. The absorption spectra obtained at 4, 20, and 35°K were quite similar to each other and to the spectrum obtained at 20°K with a ferromagnetic Dy metal absorber. Sudden disappearance of the hyperfine structure was observed between 80 and 90°K, indicating that a Raman process dominates the relaxation mechanism in Dy_2O_3 at temperatures above 80°K; theoretical calculations indicate that an Orbach process predominates at lower temperatures. (D.C.W.)

37156 SPECIFIC HEAT OF SOLID He^4. J. P. Franck (National Research Council, Ottawa). Phys. Letters, 11: 208-10(Aug. 1, 1964).

The specific heat of solid ^4He was measured at temperatures from 1.3 to 4°K and for molar volumes from 10.85 to 16.30 cm^3/mole. Both annealed and unannealed samples

were studied. Debye temperatures were calculated from the data and were extrapolated to 0°K. The Debye temperatures and the anomalous term in the specific heat were also obtained from a plot of the specific heat as a function of temperature. The results were compared with other determinations. (D.C.W.)

37157 ISOTOPE EFFECTS IN THE TEMPERATURE DEPENDENCE OF THE PURE QUADRUPOLE RESONANCE SPECTRA OF Cl^{35} AND Cl^{37} IN TRICHLORACETIC ACID. R. Blinc, J. Porok, and I. Zupančič (Nuclear Inst. "Josef Stefan," Ljubljana, Yugoslavia and Univ. of Ljubljana, Yugoslavia). Physik Kondensierten Materie, 2: 139-45 (1964).

The pure quadrupole resonance spectra of ^{35}Cl and ^{37}Cl in polycrystalline CCl_3COOH were measured as a function of temperature. Both the ^{35}Cl and the ^{37}Cl spectra are triplets, the frequency separation between the components being proportional to the quadrupole moments of the ^{35}Cl and ^{37}Cl nuclei. A small, but definite isotope effect was found in the ^{35}Cl and ^{37}Cl $(\omega_m - \omega)/\omega_m$ versus temperature curves. The direction of this effect shows that other than torsional frequencies are as well effective in averaging the electric field gradient tensor at the chlorine sites. The ^{37}Cl spectra become unobservably weak above −149°C, whereas the ^{35}Cl spectra broaden beyond observation at −134°C, at a temperature twenty seven degrees higher than previously reported. Order−disorder phenomena rather than hindered rotation of the CCl_3 groups at a rate comparable to the quadrupole resonance frequencies are shown to be responsible for the disappearance of the resonance pattern at the transition temperatures. (auth)

37158 INVESTIGATION OF THE ENERGY STRUCTURE OF Be AND BeO BY ULTRA-SOFT X-RAY SPECTROSCOPY. A. P. Lukirskii and I. A. Brytov (Leningrad State Univ.). Soviet Phys.-Solid State (English Transl.), 6: 33-41(July 1964). (Translated from Fiz. Tverd. Tela, 6: 43-53(Jan. 1964).

Emission and absorption spectra were obtained in an x-ray spectrometer for metallic beryllium, beryllium in BeO, and oxygen in BeO. The width of the filled part of the valence band for metallic beryllium was determined from its emission spectrum. Fine structure was observed in the absorption spectrum of metallic beryllium. The emission spectra of BeO are complex. They were compared with the absorption spectra in an attempt to interpret the spectra and to determine the width of filled and forbidden bands in the region of beryllium and oxygen atoms. Energy-level diagrams are constructed for metallic beryllium and beryllium oxide. The essential result is that the diagrams for the regions near beryllium and oxygen are different. The hypothesis is advanced that the filled band near beryllium is formed by electrons taking part in covalent bonds. The K level of beryllium in BeO is shifted relative to that in metallic beryllium. The quantum yield of the external photoeffect of a BeO photocathode was investigated in the region of the beryllium and oxygen absorption edges. The relation between quantum yields and absorption spectra was established. An attempt was made to interpret the spectral dependence of quantum yield. (auth)

37159 ELECTROLYTIC DISSOCIATION OF ZIRCONIUM AND BORON OXYFLUORIDE ALLOYS. P. A. Polishchuk (Dnepropetrovsk Chemical and Tech. Inst., USSR). Ukr. Khim. Zh., 30: 469-74(1964). (In Russian)

Electrolytic dissociation of $K_2ZrF_6-B_2O_3$ in LiF−NaF was used to prepare ZrB_2. (R.V.J.)

37160 ISOTOPIC EFFECTS IN SINGLE FILAMENT THERMAL ION SOURCES. A. Eberhardt (Universität, Bern), R. Delwiche, and J. Geiss. Z. Naturforsch., 19a: 736-40(June 1964).

Isotopic effects occurring during the evaporation of microgram quantities of chemically pure rubidium, potassium and lithium compounds are studied. The measured isotopic ratios show a time dependent variation corresponding to a Rayleigh distillation. The fractionation factor is equal to the square root of the ratio of the masses. The highest observed enrichments are 45% for lithium, 10% for potassium and 5% for rubidium. The measured isotopic ratio depends also on the filament material and on the chemical composition of the sample. The discriminations are of the order of the square root of the ratio of the masses. (auth)

37161 MECHANISM OF URANIUM OXIDE REDUCTION BY CARBON. V. G. Vlasov, E. V. Tkachenko, and A. G. Lebedev. Zh. Prikl. Khim., 37: 1414-20(July 1964). (In Russian)

The results of experiments on the interaction of amorphous UO_3 and U_3O_8 with solid carbon at temperatures below 800°C are reported. Increasing the pressure from 1000 to 6700 kg/cm^2 increased the rate of the reduction. When the briquettes were pulverized, the reaction rate with the resulting powder was considerably increased. When powder from briquettes formed at 1000 kg/cm^2 was subjected to CO_2 at pressures ranging from a vacuum to 720 mm CO_2, a retarding effect was observed. With U_3O_8-C, the reduction rate increased with both increasing briquette-formation pressure and increasing CO_2 pressure. (IIC-MG)

37162 STUDIES OF ORGANOMETALLIC COMPOUNDS OF TECHNETIUM AND ITS CONGENERS. Dale Kay Huggins. Thesis, Los Angeles, Univ. of California, 1964. 172p.

Trimeric tetracarbonyls of technetium, rhenium, and manganese were synthesized by the action of sodium amalgam or sodium borohydride on the corresponding di-metal decacarbonyls, followed by acidification. A structure containing a triangular arrangement of the metal atoms is proposed for these compounds, and the evidence supporting this proposed structure is discussed. The pentacarbonyl hydride of technetium was synthesized by the acidification of the sodium salt of ditechnetium decacarbonyl. From the infrared spectra in the carbonyl stretching region of the new derivative, and of the corresponding derivatives of manganese and rhenium, the pentacarbonyl hydrides are concluded to be, most probably, octahedrally coordinated with the four radial carbonyl groups slightly inclined toward the hydrogen. A cyclopentadienyl derivative of technetium was synthesized by the reaction of sodium cyclopentadienide with technetium tetrachloride. The characterization of the new compound is described and the data bearing on the possible structure of the compound are discussed. (Dissertation Abstr., 24: No. 12, Pt. I(June 1964))

Organic Chemistry

Refer also to abstract 37247.

37163 (AD-418409) SYNTHESIS OF POTENTIAL ANTI-RADIATION AGENTS. Terminal Report. Henry G. Mautner (Yale Univ., New Haven. School of Medicine). Sept. 19, 1963. 6p.

In the hope of increasing the specificity of the radioprotective action of 2-mercaptoethylamine and of protecting the genetic material of the cell, which is peculiarly sensitive to radiation damage, a group of N-5-pyrimidyl cysteamines, of N-8-purinyl cysteamines, and of related compounds was prepared. The selenium analogs of cysteamine and of aminoethylisothiouronium bromide hydrobromide and of related radioprotective mercaptans were synthesized. In the search for mercaptan and selenomercaptan derivatives stable to oxidation, but capable of being hydrolyzed within the host to be protected against ionizing radiation, a group of thioacyl and selenoacyl compounds was synthesized and the kinetics of their hydrolysis and aminolysis reactions investigated. (auth)

37164 (AD-434058) SYNTHESIS OF POTENTIAL ANTIRADIATION DRUGS. Report No. 56. Annual Summary Report and Final Report, October 1, 1962–March 31, 1964. Leon Goodman, James E. Christensen, and Sandra L. Holton (Stanford Research Inst., Menlo Park, Calif.). Contract DA-49-193-MD-2068. 23p.

Progress in the preparation of radioprotective compounds is reported. The synthesis of 6-acetamido-1,2,3,4-tetra-0-acetyl-6-deoxy- -L-idothiapyranose was completed. This represents an interesting type of sugar that contains sulfur as the heterocyclic ring atom and possesses a neighboring N-acetyl group. An extension of this synthetic method can probably be used to give the free sugar, 6-amino-6-deoxy-5-thio-L-idose, an interesting substituted beta-mercaptoethylamine. Tryptamine was mercaptoethylated to yield N-(2-mercaptoethyl)-tryptamine hydrochloride. A number of ethylenimines were converted to thiols, Bunte salts, and isothiuronium salts. The most extensive group of compounds of this type came from the reaction of DL-propylenimine with meso-1,2:3,4-diepoxybutane that gave three stereoisomeric bis-aziridines. The bisaziridines in turn were converted to the respective bis-thiols, bis-Bunte salts, and bis-isothiuronium salts. Several of the compounds were submitted for biological evaluation in mice. (C.H.)

37165 (AD-438520) INVESTIGATION OF FLUORO COMPOUNDS FOR THERMAL PROTECTION. Final Summary Report, April 19, 1961–April 18, 1963. J. M. Butler and L. E. Erbaugh (Monsanto Research Corp. Dayton Labs., Ohio). Contract DA-19-129-QM-1773. 171p.

The thermal degradation of halo-polymers was studied in relationship to possible processes of thermal protection. The kinetics and energetics of the thermal degradation of polyethylene, polyvinyl fluoride, polyvinylidene fluoride, polyvinyltrifluoroethylene, polytetrafluoroethylene, polyvinyl chloride, and polyvinylidene chlorofluoride, were investigated by thermogravimetric analysis and differential thermal analysis. It was concluded that energy absorption by endothermic decomposition is not a major factor in the thermal protection afforded by these polymers, nor does endothermic decomposition account for the differences in thermal protection shown by the different polymers. Theoretical and experimental studies were made to relate smoke formation to thermal protection. The results support, but do not prove, the hypothesis that attenuation by smoke from the decomposition of a material is a significant factor in the protection afforded against high intensity thermal radiation. (auth)

37166 (NP-14237) GLYCIDIC ESTERS AND/OR ORGANIC DISULFIDES, AND RELATED SUBSTANCES, AS SOURCES OF ANTI-RADIATION DRUGS. Interim Research Report No. 19, April 1–June 30, 1964. R. B. Barbee, J. D. Buckman, H. K. Kim, W. B. Lacefield, and L. Field (Vanderbilt Univ., Nashville). Contract DA-49-193-MD-2030. 25p.

Five compounds were submitted for screening as radioprotective compounds making a total of 77 submissions. Research was initiated on the synthesis of cyclic disulfides and the corresponding thiosulfonates. Reaction of a dialkyldithiocarbamate with a thiosulfonate was improved by decreasing the reaction time. Reaction also was demonstrated to occur nicely with a t-butyl thiosulfonate, but the reaction proceeds more slowly than with primary alkyl or aryl thiosulfonates; identity of the t-butyl thiocarbomyl disulfide produced was established by independent synthesis. The requisite t-butyl thiosulfonate, apparently the first known, was synthesized by two routes and was structurally confirmed also by conversion to a known disulfide; it was shown to react much more slowly with benzenethiol than do primary alkyl or aryl thiolsulfonates. An improved synthesis was developed for o-(2-aminoethyldithio)benzenesulfonic acid. This synthesis permitted isolation of analytically pure material. The structure was confirmed by oxidation to taurine and potassium o-benzenedisulfonate. This disulfide proved to be resistant to disproportionation. Disproportionation of five other o-(2-aminoethyldithio) compounds was studied. In contrast to the para series, the order of reaction could not be clearly determined, nor was there any clear relation between the sigma constants of substituents and the rate of disproportionation. There did not seem to be any useful correlation between ease of disproportionation and radioprotective activity. Investigation of possible synthesis of mercaptodisulfides was continued. Diphenyl dithiosulfite appears to be much less stable than di-t-butyl dithiosulfite but appears to decompose by the same mechanism. A means for following the decomposition of the t-butyl ester by its infrared spectrum was developed. Study of the reaction of di-t-butyl dithiosulfite with a thiol is reported in progress. (auth)

37167 A CARBON-BY-CARBON DEGRADATION OF CARBON-14-LABELED NICOTINIC ACID. David R. Christman, Ray F. Dawson, and Karin I. C. Karlstrom (Brookhaven National Lab., Upton, N. Y., and Columbia Univ., New York). J. Org. Chem., 29: 2394-7(Aug. 1964). (BNL-7902)

A carbon-by-carbon chemical degradation of carbon-14-labeled nicotinic acid is presented that is capable of giving the specific activity of each carbon atom in the molecule directly. With reasonably good counting equipment, the method can be applied to nicotinic acid containing 5 μC of activity in 2–3 mmoles. Randomly labeled acid containing this level of activity would produce carbon dioxide in the final stages with a specific activity of about 0.1 mμC/mg of carbon. (auth)

37168 THE SYNTHESIS AND INFRARED SPECTRUM OF 3-DEUTERIOINDOLE. R. L. Hinman and C. P. Bauman (Union Carbide Corp., Tarrytown, N. Y.). J. Org. Chem., 29: 2437-8(Aug. 1964).

By refluxing a solution of indole in D_2O containing 5×10^{-3} M H_2SO_4, exchange of the β proton was accomplished, yielding 1,3-dideuterioindole. This in turn was converted to 3-deuterioindole by refluxing with water. The latter product had an isotopic purity of 87%, as determined by NMR. Of three characteristic strong peaks at 13.05, 13.45, and 13.85 μ in the indole spectrum, that at 13.05 μ disappeared completely in the deuterated material, and that at 13.85 μ was reduced to a weak absorption at 13.70 μ. New peaks in the deuterated material included a band of moderate intensity at 12.1 μ (830 cm^{-1}), a strong band at 12.4

(808), and what appeared to be an overtone of the former at 6.05 (1660). Thus, the presence of deuterium at the 3-position can be detected by the band at 12.4 μ, and residual C–H at that position can be estimated quantitatively from the absorption at 13.85 μ. (P.C.H.)

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Refer also to abstracts 37311, 37550, 37560, 37783, 37784, 38506, 38243, 38264, and 38469.

37169 (A/CONF.28/P/112) CONTINUOUS METHODS OF TRACING CHEMICAL CHANGES IN FLUIDS UNDER GAMMA IRRADIATION. S. Minc, Z. P. Zagórski, and R. Broszkiewicz (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). May 1964. 20p.

Two methods were developed for the continuous analysis of solutions during gamma radiolysis: spectrophotometry and polarography. A special cobalt-60 source for the spectrophotometric measurements is described. Results are presented of studies of Fe^{2+} solutions with and without organic compounds, and of alkaline sulfite solutions. (D.L.C.)

37170 (A/CONF.28/P/113) RADIATION CHEMISTRY IN ALKALINE SOLUTIONS. B. Ježowska-Trzebiatowska and J. Kaleciński (Polish Academy of Sciences. [Inst. of Physical Chemistry], Wrocław). May 1964. 15p.

The reduction of chromates and manganates and the oxidation of I^- to I_2 in alkaline solutions under gamma irradiation were studied over a wide pH range. Molecular and radical yields were calculated from the results. Evidence that OH radicals act as reducing agents was noted. (D.C.W.)

37171 (A/CONF.28/P/389) RADIATION-THERMAL CRACKING OF CRUDE, OIL STOCKS AND HYDROCARBON GASES. L. S. Polack (U.S.S.R.). May 1964. 18p.

Investigations were carried out on the radiation-thermal cracking (RTC) of different hydrocarbon and oil stocks. Both electron and reactor radiations were used. The effects of temperature, pressure, and dose rate on RTC product yields were studied. The optimal conditions for RTC range from 400 to 600°C at 1 to 3 atm, depending on the dose rate. The economics of RTC are compared with those of pyrolysis in tube furnaces. (D.L.C.)

37172 (A/CONF.28/P/458) NEW DEVELOPMENTS IN THE ACCELERATED ISOTOPIC LABELLING OF ORGANIC COMPOUNDS. N. A. Ghanem (Egypt. National Research Centre, Cairo). May 1964. 18p.

New developments in producing labeled organic compounds in the laboratory in a matter of a few minutes are described, and the method's advantages are outlined. A microwave generator was used to produce microwave energy of about 12 cm wave length, 2425 MHz frequency, and continuously variable power output between 20 and 250 W. This was used as a tool for accelerating exchange reaction, but not ion acceleration, between tritium gas and a variety of anesthetic and other products to produce unspecific and specific labeling in the order of 50mC/g or more depending on the amount of material. Among these products are carbocaine, procaine, tetracaine, xylocaine, and L-cocaine. The energy was concentrated in a spherical specially constructed but simple cavity where the resonance frequency obtained by a tuning device allows an electrodeless discharge to be produced in the reaction tube. The new features of the method are stressed. (auth)

37173 (A/CONF.28/P/566) FACTORS CONTROLLING REACTION BETWEEN GRAPHITE AND RADIOLYSED CARBON DIOXIDE. R. Lind (United Kingdom Atomic Energy Authority. Reactor Group, Culcheth, Lancs, England), and J. Wright. May 1964. 15p.

A review is presented of information obtained from basic investigation carried out in rigs in materials testing reactors on the radiation-induced reaction between carbon dioxide and graphite. ^{14}C tracer techniques have been particularly useful in this work and their development and application are described. The principal parameters governing the reaction have been found to be the gas density and the porous structure of the graphite. In particular the reaction rate depends on the volume of the pores accessible to the external atmosphere and the amount of radiation energy absorbed by gas in these pores. Temperature and pressure have little specific effect apart from controlling the gas density and therefore the energy absorbed. The reaction is described in terms of the formation of active species in the gas within the porous structure; these migrate to and react with a carbon surface. Activated carbon dioxide molecules and oxygen atoms have been postulated as two types of active species. It is possible that both are important under different conditions. The effects of attack on the graphite structure after massive (up to 19%) weight losses are described in terms of opening up of the closed pore structure. It is suggested that two types of closed pore are involved–(1) macropores which are similar in character to the open pores, and which open up rapidly during the early stages of the oxidation, and (2) micropores which may be part of the crack structure and which open up in proportion to the carbon removed. Small quantities of additives to the carbon dioxide can have a disproportionate effect on the reaction rate, and limited inhibition was observed with carbon monoxide, hydrogen, and water vapor. Methane has been shown to be even more effective. The effects have been attributed to interference with surface processes. (auth)

37174 (A/CONF.28/P/830) CONTRIBUTION TO THE UNDERSTANDING OF NATURAL EVOLUTION OF PETROLEUM: RADIATION EFFECTS ON CRUDE OILS. Umberto Colombo, Ennio Denti, Giuseppe Sironi, and Edoardo Zimmer (Societa Richerche Impianti Nucleari. Centro Richerche Nucleari, Saluggia, Italy). May 1964. 24p.

Results are presented of irradiation experiments on some Italian crude oils in the presence of different sedimentary rocks and water, in environmental conditions similar to those known for sedimentary basins. The total radiation doses employed are comparable to those which may be absorbed in geologic times by organic material associated with more or less radioactive shales. Considerable radiation effects on the structure, distribution of molecular weights, and viscosity of irradiated crudes were found. Along with the formation of complex condensed molecules, light liquid and gaseous products are formed. Worthy of note is the fact that irradiation in the presence of certain natural catalysts, particularly when water-wet, leads to the formation of much less hydrogen and unsaturated molecules than are obtained when crude oils are irradiated without catalysts. This might explain why despite the primary role that radiation is believed to have played in the natural evolution of petroleum, at least in some instances neither hydrogen nor unsaturated products are very abundant in sedimentary basins. In connection with these experiments it was found that irradiation of crude oil and of their distillation fractions in the presence of suitable catalysts brings

about interesting chemical modifications which improve the quality of the oil in relation with its subsequent refining and chemical utilization. (auth)

37175 (AEET/CD/20) STUDIES ON THE PYROLYTIC AND RADIOLYTIC STABILITIES OF ORGANIC COOLANTS. Period Covered: April 1, 1962–October 31, 1963. K. Narayana Rao, R. Mahadeva Iyer, K. V. S. Rama Rao, D. Meenamani, S. K. Jain, M. S. Panajkar, and K. N. Bhide (India. Atomic Energy Establishment, Trombay). 1963. 28p.

The effects of temperature, gamma radiation, and reactor radiations on Santowax R and OMI are evaluated. (N.W.R.)

37176 (BNL-874) PROCESS RADIATION DEVELOPMENT PROGRAM SUMMARIES, FOURTH ANNUAL CONTRACTORS MEETING, JUNE 18-19, 1964, BROOKHAVEN NATIONAL LABORATORY, UPTON, LONG ISLAND, NEW YORK. (Brookhaven National Lab., Upton, N. Y.). Contract AT-30-2-GEN-16. 48p.

Twenty-four articles are included. Each is abstracted separately. (P.C.H.)

For abstracts of individual papers see: 37062, 37177, 37178, 37179, 37180, 37181, 37182, 37183, 37184, 37185, 37186, 37187, 37188, 37189, 37190, 37191, 37192, 37311, 37508, 37509, 37662, 37760, 37761, and 37762.

37177 (BNL-874(p.1-2)) APPLICATION OF RADIATION TO REACTION OF GASES. Arthur M. Feibush (Air Reduction Co., Inc., New York).

An investigation was made on the radioinduced oxidation of unsaturated hydrocarbons. The gases investigated included acetylene, ethylene, butadiene, and methylacetylene. The general structure and chemical nature of the solid products obtained from these gases were all similar. The oxidation-polymerization reaction was preferential to the formation of homopolymer. Complete oxidation of the hydrocarbons did not occur to any appreciable extent. (P.C.H.)

37178 (BNL-874(p.3-4)) THE RADIATION-INDUCED POLYMERIZATION AND COPOLYMERIZATION OF UNUSUAL MONOMERS. V. T. Stannett (Research Triangle Inst., Durham, N. C.).

Single crystals and finely powdered samples of trithiane were irradiated at room temperature with ^{60}Co gamma rays to doses from 1 to 10 MRads. Polymerization occurred during subsequent heating of the samples at 180°C, a temperature 35°C below the melting point of trithiane. The conversion to polythiomethylene after a given time of heating at 180°C is dependent on radiation dose, although there appears to be a marked saturation effect at higher doses. A study was also made on the radioinduced copolymerization of formaldehyde and styrene at −78°C. Simple mixtures of the two monomers polymerized to varying amounts, according to composition from nearly zero with pure polystyrene to 100% with pure formaldehyde at 10 MRads. Another system studied was sulfur dioxide–diene mixtures. These gave very high yields of a 1:1 copolymer, particularly at low temperatures. Isoprene, chloroprene, and butadiene were all studied and gave good yields. (P.C.H.)

37179 (BNL-874(p.5)) RADIATION-INDUCED EMULSION POLYMERIZATION. V. T. Stannett (Research Triangle Inst., Durham, N. C.).

Preliminary investigations for a future study on the preparation and properties of synthetic lattices of polystyrene, polyvinyl acetate, and other polymers using gamma radiation for the initiation are discussed. (P.C.H.)

37180 (BNL-874(p.8-9)) RADIATION-INDUCED FORMATION OF ORGANO-TIN COMPOUNDS. John F. Kircher (Battelle Memorial Inst., Columbus, Ohio).

The formation of organo-tin compounds and most specifically dibutyl tin dibromide by irradiation is reported. The reaction of n-butyl bromide and tin under the influence of gamma radiation shows an induction period. The period varies a little depending on the tin, the particle size, and pretreatment but is generally overcome at a dose of approximately 5×10^5 R and irradiation temperature of 100-101°C. Both temperature and the particle size of tin influence the reaction. In general, as the particle size becomes smaller the amount of product increases. Washing the surface with dilute HCl for about half an hour is effective in removing surface contaminants and hence increasing yields. The reaction of HBr to the reaction mixture also helps overcome the induction period. (P.C.H.)

37181 (BNL-874(p.12-13)) RADIATION CHEMISTRY OF FLUOROCARBONS AND RADIATION SYNTHESIS OF FLUORINE COMPOUNDS. Paul Y. Feng (Illinois Inst. of Tech., Chicago. IIT Research Inst.).

Studies on the radiation chemistry of fluorocarbons were carried out either using only a selected fluorocarbon as the irradiated material, or using the fluorocarbon mixed with other compounds that could react with the intermediates produced by radiation. Particular emphasis was given to the radiation chemistry of CF_3Cl and CF_4. It was found that both ionic and radical species are formed in reasonable yields ($G(ion) \simeq G(radical) \gtrsim 2$) during the radiolysis of the simple fluorocarbons. Studies were also made on the synthesis of compounds of the $Ar-CF_2X$ type, trifluoromethylstyrene, and aliphatic fluorocarbons using the $CF_4-C_2H_2$ system. (P.C.H.)

37182 (BNL-874(p.16-17)) APPLICATION OF METAL-ORGANIC BOND RADIOLYSIS TO RADIATION DOSIMETRY. Joseph Kivel (Atlantic Research Nuclear Corp., Alexandria, Va.).

Rupture of the metal to organic bond to form free metal ions provided the basis for an investigation. Systems studied were classified as: metal-acetylacetone chelates; organometallic compounds, such as tetraphenyl tin; and metal-cupferrates. Acetylacetonates of Cr and Co dissolved in toluene or ethylbenzene were found to be the most promising systems. Advantages of these systems in addition to low G value include chemical stability, elimination of oxygen requirements and ease of product analysis. Irradiations were carried out using 400 and 5000°C ^{60}Co sources. Dose rates from 2.5×10^4 to 7.7×10^5 Rads per hour were used to irradiate samples to a total dose of up to 50 MRads. The G values for the Co(III) and Cr(III) acetylacetonates in toluene systems were determined to be 0.13 and 0.10 molecules/100 ev, respectively, at 1% chelate concentration, and 0.096 and 0.067 molecules/100 ev, respectively, for the 0.1% concentration. (P.C.H.)

37183 (BNL-874(p.22)) INITIAL OPERATIONS AT THE HIGH-INTENSITY RADIATION DEVELOPMENT LABORATORY. Otto A. Kuhl (Brookhaven National Lab., Upton, N. Y.).

Primary objectives of the initial work at the High Intensity Radiation Development Laboratory (HIRDL) were to prove out various operational techniques and to prepare radiation sources. To fulfill these requirements, approximately 300,000 C of ^{60}Co were remotely removed from the

assemblies used for pile irradiation, then encapsulated, and each Co strip tested. In order that these elements be used sensibly, it was necessary to calibrate each one, and, therefore, a unit was developed that indicates not only the total Curies in each element but also the activity distribution. Final encapsulation of these elements, two to an envelope, was accomplished by pairing them according to the results obtained from each calibration. (P.C.H.)

37184 (BNL-874(p.23)) Co^{60} GAMMA-RADIATION-INDUCED POLYMERIZATION AND COPOLYMERIZATION OF ETHYLENE. Meyer Steinberg (Brookhaven National Lab., Upton, N. Y.).

An extensive study was made on the ^{60}Co gamma radiation-induced synthesis of copolymers of CO and ethylene (E). The final copolymer composition as a function of the initial E/CO composition from 0.05 to 87 was determined. The polymers exhibit a polyketone structure with E/CO ratio of between 1 and 2 when initial composition is >0.23. The rate of polymerization and the reactivity ratio of the 1:1 E/CO gas mixture decreases with increasing temperature. Kinetic correlations based on steady state theory and determination of the activation energy were made. Measurements with a differential scanning calorimeter indicate a crystalline melting point of 240°C for the 1:1 E/CO copolymer produced at 2500 and 10,000 psi. Decomposition occurs at 290°C. (P.C.H.)

37185 (BNL-874(p.24-5)) COMBINED EFFECTS OF ULTRA-HIGH PRESSURE AND RADIATION ON ORGANIC MONOMERS AND POLYMERS. Charles J. Marsel and Martin Prince (New York Univ., New York).

The combined effects of radiation and ultra-high pressure (greater than 200,000 psi) on various monomeric and polymer systems were studied. Studies were made on the post-irradiative high pressure polymerization of acrylamide, using gamma or electron beam irradiation. Radicals formed by radiation of monomeric acrylamide were frozen at −198°F, and subsequently polymerized at pressures up to 500,000 psi, and temperatures varying from ambient to 150°C. High pressure polymerization gave large increases in molecular weight over non-pressurized systems; in some cases a 100% increase was observed. Techniques were developed for encapsulating both solid and liquid samples at pressures up to 500,000 psi and temperatures up to 200°C. Sample materials ranged from inorganic materials to organic plastics. Several sterically hindered ethylene derivatives were also studied using the post-irradiation high pressurization technique. These included tetrachloroethylene, tetrabromoethylene, tetraiodoethylene, tetracanoethylene, and tetraphenylethylene. Investigation of the acrylonitrile systems aimed at producing novel triazine polymers produced an interesting side reaction. (P.C.H.)

37186 (BNL-874(p.27-8)) UPGRADING OF BY-PRODUCT POLYPROPYLENE BY RADIATION TECHNIQUES. Bruce S. Bernstein and Joseph Lee (Radiation Applications Inc., Long Island City, N. Y.).

During the preparation of polypropene from the monomer via ionic catalysis, both stereoregular (isotactic) and atactic polymer was produced. Attempts were made to modify the atactic polymer via radiation techniques coupled with the use of additives, in order to obtain materials of greater utility. The polymer was modified by blending with various amounts of a silica filler having a particle size of 0.015 μ, and subjected to radiation with and without a crosslinking monomer, such as allyl methacrylate. The purpose was to build up the molecular weight and simultaneously improve the physical properties. A 10-MRad dose incorporated about 40% of the atactic polypropene into the gel fraction with the aid of allyl methacrylate, regardless of whether silica was present or absent. The resultant radiation-treated modified polypropylenes were somewhat tougher upon physical examination, as compared to unirradiated or filler-free irradiated specimens. (P.C.H.)

37187 (BNL-874(p.29-31)) RADIATION-INDUCED OXIDATION OF HYDROCARBONS. Arthur A. Armstrong, Jr. (North Carolina State Coll., Raleigh).

It is proposed to study the radioinduced oxidation of hydrocarbons using a ^{60}Co irradiation facility. The study will cover the effects of temperature, pressure, and concentration. Experiments will be made to find sensitizers that will increase the rate of initiation and to find compounds and conditions that will propagate a chain reaction. The hydrocarbons chosen for the program are ethane, propane, isobutane, toluene, ethylbenzene, and cumene. (P.C.H.)

37188 (BNL-874(p.32)) RADIATION SYNTHESIS OF ARTIFICIAL KIDNEY MEMBRANES. George Odian and Edward F. Leonard (Columbia Univ., New York).

The objective is the development of improved dialysis-ultrafiltration membranes for use in artificial kidney devices. The requirements for the desired artificial kidney membranes are very high permeability and physical and chemical integrity. It is planned to study the synthesis of such membranes via the radiation modification of polyvinyl alcohol. Radiation crosslinking of polyvinyl alcohol with and without polyfunctional monomers will be investigated. (P.C.H.)

37189 (BNL-874(p.35-6)) EVALUATION OF BETA RADIATION AS A CATALYST. P. M. Yavorsky and E. Gorin (Consolidation Coal Co., Pittsburgh).

A new beta irradiator was constructed that consists of a helix, 4 in. high by 1 in. dia formed from a single 9 ft by 0.077 in. OD tube bearing 400 C of ^{90}Sr titanate. In addition to dosimetry, to prove-out the efficacy of the new irradiator-continuous reactor system, two reactions known to be radioinduced were run. The beta radiation was found to promote hydrocracking of n-decane at a rate three times that of thermal hydrocracking in the temperature range 400 to 440°C. For the combination reaction between 6 parts of isobutane and 1 part of propene (both gases), radiation caused a yield of 54.5 g of liquid hydrocarbons per 100 g of propene, with an approximate G-value of about 500. For coal extract and decalin, it was definitely concluded that only marginal amounts of radioinduced hydrocracking were produced; not enough to compete with contact catalyst processes. (P.C.H.)

37190 (BNL-874(p.37-8)) WOOD-PLASTIC COMBINATIONS. James A. Kent (West Virginia. Univ., Morgantown).

Studies were made on the parameters involved in preparing wood-plastic combinations using radiation polymerization techniques and the physical and chemical properties of the products. It was found that oxygen is harmful to polymerization reactions. The molecular weights of poly(methylmethacrylate) and poly(vinyl acetate) formed at various dose rates, both inside and outside of wood substrates, were determined. It was also found that dyes can be incorporated into wood-plastic combinations to produce colored products. (P.C.H.)

37191 (BNL-874(p.39-40)) A LABORATORY STRONTIUM BETA IRRADIATOR AND STUDIES SHOWING RADIATION SURFACE CATALYSIS. William H. Johnston (Johnston (William H.) Labs., Inc., Baltimore).

A convenient laboratory beta irradiator utilizing 600°C of ^{90}Sr was constructed. Using this irradiator, studies of the nitrous oxide dosimeter revealed an interesting radiation catalyzed surface decomposition reaction of N_2O. The beta irradiator was designed to eliminate the need for special precautions or facilities in laboratory use, by utilizing the shipping container as the laboratory radiator. A theoretical model was also developed for the surface decomposition of N_2O. (P.C.H.)

37192 (BNL-874(p.41-4)) WORKING THEORY FOR SEEKING IMPORTANT RADIATION PROCESSES. William H. Johnston (Johnston (William H.) Labs., Inc., Baltimore).

A generalized working theory for ionic chain reactions is given and then illustrated by the radiation of ammonia and isobutylene, C_4H_8. Proposed ionic change concepts are emphasized. Mixtures of ammonia and isobutylene were irradiated in a Strontium Beta Irradiator. The results showed a G value of 40 ± 5 suggesting a chain reaction. (P.C.H.)

37193 (AEC-tr-6398(p.205-12)) RADIOLYSIS OF CERTAIN INORGANIC COMPOUNDS IN A FIELD OF INTENSIVE GAMMA IRRADIATION. I. M. Blaunschtein and S. V. Starodubtsev. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 163-?(1961).

The radiolysis of solid chemical compounds was studied from the viewpoint of gaseous and solid yields to determine the relation between absorbed energy and number of bonds broken. Results are given for $BaCl_2$, LiH, $CaCO_3$, $KMnO_4$, and powders of glass, quartz, etc. Doses were 30 to 100 MR. (R.E.U.)

37194 (AEC-tr-6398(p.213-17)) VARIATION OF THE OPTICAL PROPERTIES OF BENZENE, IRRADIATED BY GAMMA RAYS. M. N. Gurskiĭ, A. G. Sizȳkh, and S. V. Starodubtsev. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 168-?(1961).

Luminescence, optical activity, index of refraction, and absorption spectrum of pure benzene were studied for gamma dose rates of 0.3×10^6 R/hr and doses of 16×10^6 R. (R.E.U.)

37195 (AEC-tr-6398(p.218-21)) PHOSPHORESCENCE OF CRYSTALLINE QUARTZ UNDER THE INFLUENCE OF GAMMA IRRADIATION. Sh. A. Vakhidov and S. V. Starodubtsev. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 171-?(1961).

The quenching of phosphorescence of crystalline quartz from various deposits, produced by gamma radiation at 10^6 R/hr, was studied. The effects of pre-irradiation electroprocessing, heating, and ultraviolet irradiation on the phosphorescence were evaluated. (R.E.U.)

37196 (AEC-tr-6398(p.222-5)) VARIATION OF THE ADSORPTION PROPERTIES OF SILICA GEL UNDER THE ACTION OF GAMMA IRRADIATION. Sh. A. Ablaev, S. E. Ermatov, and S. V. Starodubtsev. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 174-?(1961).

The sorptive properties of silica gel were found to increase substantially for hydrogen, nitrogen, carbon dioxide, ammonia, and ethylene gases after gamma irradiation to 2 MR. The adsorptive properties were determined from absorption of the gases, measured by thermocouple and ionization manometers. (R.E.U.)

37197 (AEC-tr-6398(p.226-31)) INVESTIGATION OF PROCESSES OF ENERGY TRANSFER IN THE RADIOLYSIS OF CERTAIN FROZEN HYDROCARBONS BY THE EPR METHOD. Yu. N. Molin, I. I. Chkheidze, A. A. Petrov, N. Ya. Buben, and V. V. Voevodskiĭ. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 178-?(1961).

The intra- and intermolecular energy transfer over considerable distances that can precede the cleavage of the chemical bond in the radiolysis of condensed-phase organic compounds was studied by EPR techniques for 1,1-dicyclohexyldodecane, 1,1-diphenyldodecane, 1-phenyl-1-cyclohexyldodecane, cyclohexane, and benzene. Electrons of 1.6 Mev were used. (R.E.U.)

37198 (AEC-tr-6398(p.252-7)) CONSIDERATION OF THE ACTION OF HOT ATOMS AND MOLECULES IN RADIOCHEMICAL KINETICS. A. Ya. Temkin. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: (1961).

Modes of de-excitation of excited molecules formed by high-energy particles in gases are considered from energies of chemical reactions. (R.E.U.)

37199 (AEC-tr-6398(p.258-70)) INVESTIGATIONS OF THE GAMMA CONDUCTION OF CdS SINGLE CRYSTALS. I. D. Konozenko, V. I. Ust'yanov, and A. P. Galushka. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 200-?(1961).

The production and gamma investigation of massive single crystals of CdS are described. The gamma conduction is shown to be a measure of crystal quality. (R.E.U.)

37200 (AEC-tr-6398(p.362-5)) INFLUENCE OF GAMMA RAYS ON THE ADSORPTION OF COMPLEX COMPOUNDS OF COBALT ON SILICA GEL. E. K. Vasil'eva and S. V. Starodubtsev. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 277-?(1961).

The effects of gamma radiation on the adsorptive properties of silica gel for cobalt ammines were studied using radioactive $CoCl_2$ as a tracer. (R.E.U.)

37201 (AEC-tr-6398(p.366-8)) CHANGE IN THE ABSORPTION BANDS IN THE SPECTRUM OF COLORED POLYMETHYLMETHACRYLATE UNDER THE ACTION OF GAMMA RAYS. L. G. Keitlin and S. V. Starodubtsev. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 279-?(1961).

The color change in plates of polymethylmethacrylate containing benzeneazo-α-naphthylamine as dye was studied after gamma irradiation to 0 to 4.2×10^7 R. Effects of impurities (benzene or dichloroethane) were studied. (R.E.U.)

37202 (AEC-tr-6398(p.377-85)) A RADIOCHEMICAL METHOD OF OBTAINING METALLIC CATALYSTS. A. A. Balandin, V. I. Spitsȳn, V. I. Duzhenkov, and L. I. Barsova. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 289-?(1961).

The radiochemical stability of solutions of chloro-, hydroxy-, and chlorohydroxy-substituted complex compounds of platinum was investigated. It was found that compounds having the trans-coordinate OH–Pt–Cl are entirely reduced to the metal during electron and gamma radiolysis. The radiolysis of aqueous solutions of $PdCl_2$ and K_2PdCl_4 was found to bring about complete reduction of Pd^{2+} to the metal. Catalytic activities of the so-obtained Pd and Pt were compared for low-temperature hydrogenation of cyclohexane. (R.E.U.)

37203 (AEC-tr-6398(p.386-9)) PRODUCTION OF GRAFTED CELLULOSE POLYMERS BY IRRADIATION WITH Co^{60}. Kh. U. Usmanov, B. I. Aĭkhodzhaev, and U. Azizov. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 295-?(1961).

Grafted polymers of cellulose were produced from cotton cellulose and acrylonitrile irradiated by gamma radiation to 1 to 30 MR at 250,000 R/hr. A method for determining the degree of polymerization of grafted portions is discussed. (R.E.U.)

37204 (AEC-tr-6398(p.397-402)) THE ACTION OF IONIZING RADIATIONS ON THE AMINO ACID COMPOSITION OF WATER SOLUBLE PROTEINS OF COTTON SEEDS. A. P. Ibragimov, Yu. K. Belopukhov, and A. Tuĭchiev. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 302-?(1961).

The effects of gamma radiation on the proteins of cotton seeds were studied for doses of 1 to 10 MR and 50 MR at 75 R/sec. After separation from the seeds, the water-soluble proteins were studied for salting out boundaries, variation of pH in aqueous extract, and nitrogen content, and chromatographic analyses of the amino acid composition of the hydrolyzate of the water-soluble proteins and of the aqueous extract were made. (R.E.U.)

37205 (AEC-tr-6398(p.403-7)) DETERMINATION OF THE SULFHYDRYL GROUPS OF PROTEINS OF IRRADIATED COTTON SEEDS. A. P. Ibragimov, A. Mukhamedov, and A. Tulaganov. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 306-?(1961).

The effects of gamma radiation and slow neutrons on the proteins and enzymes of cotton seeds that contain the sulfhydryl group were studied. Amperometric titration was used to determine the sulfhydryl groups in aqueous extracts of cotton seed proteins. (R.E.U.)

37206 (AEC-tr-6398(p.408-11)) ACTION OF IONIZING RADIATION ON THIOCYANATES. E. M. Nanobashvili and L. V. Ivanitskaya. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 310-?(1961).

The oxidation-reduction processes taking place during x-irradiation of true and colloidal solutions of thiocyanates of potassium, ammonium, silver, copper, and iron were studied. The electroconductivity, pH, viscosity, turbidity, and ionic composition of the irradiated solutions were determined for increasing amounts of absorbed energy. The oxidation-reduction products were determined by potentiometric titration. (R.E.U.)

37207 (AEC-tr-6398(p.421-8)) RADIOCHEMICAL CONVERSIONS OF HIPPURIC ACID. E. M. Lapinskaya, M. A. Khenokh, and V. F. Evdokimov. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 319-?(1961).

Hippuric acid, a benzoyl derivative of glycine, was gamma irradiated at 4.2 to 10.5×10^{16} ev/ml sec in air, under vacuum, and in crystalline form. Yields of ammonia, phenols, glycine, and carbonyl compounds were determined. Chromatographic analysis was performed. (R.E.U.)

37208 (AEC-tr-6398(p.434-43)) SENSITIZATION OF THE RADIOLYTIC OXIDATION OF LEUCO FORMS OF DYES. V. D. Orekhov and A. A. Zansokhova. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 328-?(1961).

The effects of gamma rays on aqueous solutions of leuco compounds of dyes were studied; the possibility of sensitizing the radiolytic processes by conjugated acceptors was investigated. Radiochemical oxidation was studied for a leuco base of a thiazine dye, methylene blue; sulfuric acid esters of leuco compounds of indigoid dyes, indigo sols; and a leuco compound of a dye of the triarylmethane series, a derivative of a thiophenediphenylmethane dye, 4,4'-(5-methyl-2-thenylidene)-bis-(N,N-dimethylaniline). (R.E.U.)

37209 (AEC-tr-6398(p.444-50)) IRREVERSIBLE AND REVERSIBLE CHANGES OF DIFFUSION CHARACTERISTICS OF CERTAIN POLYMERS AS A RESULT OF THE ACTION OF GAMMA RADIATION ON THE POLYMER. N. S. Tikhomirova, Yu. M. Malinskiĭ, and V. L. Karpov. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 334-?(1961).

The diffusion of helium and argon through films of crystalline and amorphous polymers after gamma irradiation was investigated to study the dependence of gas permeability of the polymers on the dose. Films of polyethylene, polyamide-54/10, methylolpolyamide-2/10, SKS-30, and polytetrafluoroethylene were irradiated under a vacuum of 10^{-5} mm of mercury at 0.77 Mrad/hr from a ^{60}Co source. (R.E.U.)

37210 (AEC-tr-6398(p.451-61)) TRANSFORMATION OF DISSOLVED SUBSTANCES DURING THE RADIOLYSIS OF AQUEOUS SOLUTIONS. M. A. Proskurnin, V. D. Orekhov, and A. I. Chernova. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 339-?(1961).

The reactions of intermediate products of radiolysis with dissolved substances were studied. Water with varying-activity acceptors was studied. (R.E.U.)

37211 (AEC-tr-6398(p.462-71)) RADIATION-ELECTROCHEMICAL PROCESSES IN AQUEOUS SOLUTIONS OF ELECTROLYTES. Ts. I. Zalkind, N. B. Miller, G. Z. Gochaliev, and V. I. Veselovskiĭ. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 347-?(1961).

Radiochemical reactions in solutions of pure sulfuric acid and in sulfuric acid solutions containing salts of quadri- and hexavalent uranium and oxalic acid were studied. The effects of gamma dose rate, solution composition, and pH of the medium were studied. Platinum, gold, and mercury electrodes were used. The water radiolysis products were investigated. (R.E.U.)

37212 (AEC-tr-6398(p.472-80)) INVESTIGATION OF CERTAIN RADIOCHEMICAL PROCESSES IN AQUEOUS SOLUTIONS AT RELATIVELY HIGH DOSE RATES. A. K. Pikaev and P. Ya. Glazunov. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 354-?(1961).

Radiolytic transformations in aqueous solutions of ferrous and ceric sulfates were studied for high electron doses. Phenomena related to overlapping of the tracks of the ionizing particles in the dilute solutions were studied for dose rates greater than 10^{21} ev/ml·sec. (R.E.U.)

37213 (AEC-tr-6398(p.481-5)) THE EFFECTS OF A FLUX OF FAST ELECTRONS ON AQUEOUS SOLUTIONS OF SILVER COMPOUNDS. G. G. Ryabchikova, V. I. Duzhenkov, and P. Ya. Glazunov. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 361-?(1961).

The possibility of producing metallic silver or insoluble silver compounds from silver waste products by irradiating with electrons was studied. Silver nitrate and silver thiosulfate were investigated. (R.E.U.)

37214 (AEC-tr-6398(p.486-94)) ELECTRON PARAMAGNETIC RESONANCE SPECTRA AND THE KINETICS OF THE ACCUMULATION OF THE PRODUCTS FORMED IN THE RADIOLYSIS OF FROZEN AQUEOUS SOLUTIONS OF SODIUM NITRATE. V. A. Sharpatyĭ and Yu. N. Molin. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 364-?(1961).

The use of EPR spectra to study radical radiolysis products is discussed. Frozen aqueous solutions of sodium nitrate were irradiated with 1.6-Mev electrons. (R.E.U.)

37215 (AEC-tr-6398(p.505-11)) DISSOCIATION OF LARGE MOLECULES DURING ELECTRON IMPACT. M. V. Gur'ev, M. V. Tikhomirov, and N. N. Tunitskii. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 378-?(1961).

Mass spectra of synthesized n-octane and n-octane-$2d_1$, n-nonane, and n-nonane-$5C^{13}$ were studied. (R.E.U.)

37216 (AEC-tr-6398(p.529-37)) ON THE IONIC MECHANISM OF POLYMERIZATION UNDER THE ACTION OF NUCLEAR RADIATIONS. A. P. Sheĭnker and A. D. Abkin. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 395-?(1961).

The mechanism of low-temperature polymerization of vinyl compounds by gamma radiation was studied in copolymerization of isobutylene–vinylidene chloride at −75 to 0°C, styrene–methylmethacrylate at −75 to 25°C, isobutylene–styrene at −78°C, and acrylonitrile–styrene at −78°C. (R.E.U.)

37217 A NEW, HIGHLY EFFICIENT RED-EMITTING CATHODOLUMINESCENT PHOSPHOR (YVO_4: Eu) FOR COLOR TELEVISION. Albert K. Levine and Frank C. Palilla (General Telephone and Electronics Labs., Inc., Bayside, N. Y.). Appl. Phys. Letters, 5: 118-20(Sept. 15, 1964).

The cathode-ray-excited fluorescence of YVO_4: Eu was investigated, together with its response to increasing electron beam intensity. The results show that YVO_4: Eu is far superior in both color and brightness to the silver-activated zinc cadmium sulfide used in color picture tubes. (D.C.W.)

37218 γ-IRRADIATION OF PURIFIED MYOGLOBINS. I. EFFECT ON PHYSICOCHEMICAL PROPERTIES. W. Duane Brown and Joan-Heos Argiroudi Akoyunoglou (Univ. of California, Berkeley). Arch. Biochem. Biophys., 107: 239-45(Aug. 1964).

Solutions of purified sperm whale and yellowfin tuna myoglobins were subjected to γ-irradiation at levels of 0 to 500 krads in nitrogen atmospheres. Samples to be irradiated included, in most instances, individual fractions of the three myoglobins that can be isolated from both whale and tuna preparations free of other proteins. Irradiated myoglobins precipitated from solution as a function of dose and concentration; least precipitation occurred with concentrations between 7 and 10 mg per milliliter. All precipitates were insoluble in 6 M urea except for one whale fraction. The absorbancy of samples in the 280 mμ region increased considerably following irradiation; in some dilute solutions an absorption maximum appeared at about 240 mμ. Changes in absorbancy in the visible region suggest that oxymyoglobins are partially oxidized, and that metmyoglobins are converted to substances with spectra similar to oxymyoglobins. There was little change in sedimentation velocity of myoglobins as a result of irradiation. Deamination of the proteins was induced by irradiation, and there was splitting of small peptide fragments not yet identified. Electrophoretic behavior was altered by irradiation, with samples subjected to 500-krad levels not moving from the origin on cellulose acetate strips, except for one whale fraction. There was an apparent loss of the sulfhydryl group of tuna myoglobins that was proportional to radiation dose; however, dialysis of irradiated material prior to sulfhydryl assay increased the −SH value. The −SH group was without apparent effect on radiation susceptibility, since whale myoglobins, which have no −SH groups, behaved similarly to tuna myoglobins in most cases. (auth)

37219 REACTION OF TETRANITROMETHANE WITH HYDRATED ELECTRONS IN GAMMA RADIOLYSIS OF WATER. K.-D. Asmus and A. Henglein (Hahn-Meitner-Institut fur Kernforschung, Berlin). Ber. Bunsenges. Physik. Chem., 68: 348-52(1964). (In German)

Tetranitromethane (TNM) reacts with the free H atoms and hydrated electrons produced in the γ radiolysis of water. One molecule of trinitromethane is formed per atom or electron. The yield of trinitromethane, which is equal to the sum of G(H) and G(e), slowly increases with TNM concentrations. This is explained by the influence of TNM on molecular processes in the spurs. In the presence of N_2O lower yields of trinitromethane were observed. A quantitative investigation of this decrease led to the following yields and rate constant: $G(H^{\alpha}) = 0.6$, $G(e) = 2.7$, and $k_{(e^-_{aq}+TNM)} = 6.2 \times 10^{10}$ mole^{-1} liter sec^{-1}. The yield of trinitromethane is 6.3 when isopropanol is present at 0.2 moles/liter. It follows from this observation that OH radicals are formed with a yield of 3.0/100 ev in the γ radiolysis of water. (All yields refer to a 6.4×10^{-4} M TNM solution.) (auth)

37220 CORRELATION OF OPTICAL ABSORPTION AND THERMOLUMINESCENCE CURVES FOR SINGLE CRYSTALS OF MAGNESIUM OXIDE. B. Thomas and E. Houston (Welsh Coll. for Advanced Tech., Cardiff, Wales). Brit. J. Appl. Phys., 15: 953-8(Aug. 1964).

Optical absorption and thermoluminescence measurements on untreated crystals of magnesium oxide showed that the crystals can be divided into two groups. X irradiation of the crystals induces an optical absorption peak at 2.3 ev in group I crystals and at 2.3 and 3.0 ev in group II crystals. Thermoluminescence curves, recorded after x irradiation of the crystals at room temperature, show a peak at 410°K for group I crystals and at 410 and 520°K for group II crystals. By an optical bleaching method, the 2.3 and 3.0 ev absorption peaks were found to be linked, respectively, with the 410 and 520°K thermoluminescence peaks. The ratio of the optical and thermal activation energies of the trapped charge carriers was found to be 3.3 for these magnesium oxide peaks. (auth)

37221 RADIATION CHLORINATION OF CERTAIN ORGANOCHLOROSILANES AND ORGANOPOLYSILOXANES. R. V. Dzhayatspanyan, M. T. Filippov, G. V. Motsarev, V. I. Zetkin, and V. R. Rozenberg. Dokl. Akad. Nauk SSSR, 155: 1163-6(Apr. 11, 1964). (In Russian)

Radiation chlorination of a 4% solution of polydimethylsiloxane rubber $[(CH_3)_2SiO]_n$ with (400,000 to 500,000 molecular weight) in CCl_4 at 0°C was carried out using a ^{60}Co source (800 g-equiv radium). At 4200 rad/min a product was obtained that was 50 to 55% chlorinated at 15

to 30 min. With polyphenylmethylsiloxane $[C_6H_5(CH_3)SiO]_n$ under identical conditions, the product was 56.1% chlorinated. Irradiation of methyltrichlorosilane and dimethyldichlorosilane showed that the contents of monochloro derivatives in a reaction mixture do not depend on the molar ratio of the reagents. Radiation dosage had no influence on the composition CH_3SiCl_3 chlorination products at 20°C, but a reduction in temperature to 0° reduced the yield. Radiation chlorination of phenyltrichlorosilane at 0 to 20°C results in a chlorine attachment to the aromatic nucleus. An additive chlorination and replacement reaction takes place at 50°C. Chlorination at 100 and 150° involves hydrogen displacement. Spectroscopic and chromatographic studies of chlorination products showed that the mixture of monochlorine derivatives contains ~70% meta-, ~20% ortho-, and ~10% para-$ClC_6H_4SiCl_3$; a 2.5-dichlorophenyltrichlorosilane (70 to 80%) prevailed in dichloride mixtures. The obtained data confirm the postulation that oxygen does not inhibit chlorination of $C_6H_5SiCl_3$ at 100 to 150°, and that an ion mechanism plays the main role. (R.V.J.)

37222 ON THE NATURE OF THE THERMAL AFTER EFFECT IN X-IRRADIATED TRYPSIN SOLUTIONS. V. N. Luzikov and E. B. Burlakova (Inst. of Chemical Physics, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 155: 1205-8(Apr. 11, 1964). (In Russian)

Effects of propylgallate on the thermal inactivation of x-irradiated trypsin were studied within the free radical concept of hidden radiation damage. Solutions of trypsin in 10^{-3}N HCl solutions (1.0 or 2.0 mg/ml) were irradiated at 2970 R/min at 0 to 15°C followed by thermal inactivation at 73.5 to 96.8°C. The results showed that propylgallate protects against thermal aftereffects. It was found that three reactions take place in the thermal aftereffect: a proper (or virtual) aftereffect which is not influenced by the propylgallate, an inactivation of native trypsin by hydrogen peroxide, and an inactivation by irradiated albumin (pseudo aftereffect). The last two reactions are prevented by propylgallate; the third is initiated by peroxide. The experiments show that the pseudo-effect is a function of radiation dose, albumin concentration, and temperature. Under certain conditions it can be considerable and should be studied further. (R.V.J.)

37223 A METHOD OF APPROXIMATELY ESTIMATING THE ABSOLUTE VALUES OF REACTION RATE CONSTANTS OF RADIATION REACTIONS IN AQUEOUS SOLUTION. A. K. Pikaev (Inst. of Physical Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 156: 916-19 (June 1, 1964). (In Russian)

Individual reaction rate constants were estimated from experimental data for the following reactions, and are given in parentheses after the reaction in units of 1/mole sec: $H + OH$ (4.5×10^{10}); $H + O_2$ (5.3×10^9); $Fe^{2+} + OH$ (2.7×10^8); $H + H$ ($1.4 + 10^{10}$); $OH + OH$ (6.4 to 8.1×10^9); $H + H_2O_2$ (1.1×10^8); $Ce^{3+} + OH$ (3.2×10^8); $NO_2^- + OH$ (1.1×10^{10}), and $Br^- + OH$ (1.6×10^{10}). The absolute values of the reaction rate constants were obtained by noting the changes in yield due to competing reactions at low doses and at high doses as imparted by a pulsed electron beam (having a short exposure duration of 5×10^{-8} seconds): $R + R \rightarrow R_2$, and $R + S \rightarrow$ product. Here R is a radical, R_2 is a molecular product, and S is a dissolved substance. It is possible to obtain values of K_2/K_1 and of $K_2/K_1^{0.5}$ from experimental data. On comparing K_2/K_1 with $K_2/K_1^{0.5}$, it is possible to determine K_2 and K_1. The values of the absolute reaction rate constants given above were derived by this method. (TTT)

37224 PHYSICAL VIEWPOINTS OF ELECTRON IRRADIATION. István Berkes (Central Research Inst. of Physics, Budapest). Energia Atomtech., 15: 254-8(June 1962). (In Hungarian)

The mechanisms of the energy losses and effects of fast electrons in penetration of a material are discussed, together with the evaluation and effect of the dose rate. Scattering of the electron beam is considered; and an evaluation of the feasibility of industrial application of electron irradiation processes is summarized, which involved cross linkage of polyethylene and the sterilization of surgical thread. (D.C.W.)

37225 OXYGEN EFFECT IN THERMAL ANNEALING OF RECOIL DAMAGE IN COBALT CHELATES. Amar Nath, K. Annaji Rao, and V. G. Thomas (Atomic Energy Establishment, Trombay, India). Indian J. Chem., 2: 331-2(Aug. 1964).

Marked oxygen-effect was observed in several cobalt complexes both in their electric conductivities and in thermal annealing of recoil damage. In the absence of oxygen (or air) the magnitude of anneal is considerably enhanced. These observations were theoretically explained. (auth)

37226 THE PREPARATION OF CERTAIN RADIOACTIVELY TAGGED ORGANOTIN COMPOUNDS. A. H. Frye and R. W. Horst (Cincinnati Milling Machine Co. and Carlisle Chemical Works, New Brunswick, N. J.). Intern. J. Appl. Radiation Isotopes, 15: 169-74(Apr. 1964).

Preparatory details are given for the synthesis of a series of radioactively tagged organotin compounds of the general class R_2SnY_2, where R is either butyl or octyl and Y is either monomethyl maleate, oxo-octyl thioglycolate, β-mercaptopropanoate, or 2-ethylhexanoate. Three radioactively tagged modifications of these compounds were prepared: in one the tag was present in the alkyl group (^{14}C), in another it was in the tin atom (^{113}Sn), and in the third it was in the Y-group (^{14}C). (auth)

37227 EXTENSION OF THE EFFICIENCY TRACING METHOD FOR THE CALIBRATION OF PURE β-EMITTERS. A. P. Baerg, S. Meghir, and G. C. Bowes (National Research Council, Ottawa). Intern. J. Appl. Radiation Isotopes, 15: 279-87(May 1964).

It is demonstrated that the efficiency tracing method for the standardization of pure β-emitters with a $4\pi\beta-\gamma$ coincidence apparatus may be extended to nuclide pairs, which are not amenable to mixing by compound formation. The mixing may be accomplished by adsorption of the two species on a matrix of colloidal silica or graphite particles on the source mount. By varying the mass of the matrix, it is possible to produce sources of a range of counting efficiencies. It is further demonstrated that by means of various external absorber foils placed on both sides of one mixed source, the counting efficiency may be varied to obtain an efficiency function equivalent to that obtained with a series of sources through self-absorption. While good mixing of activities is desirable, it is not essential for thin sources used with external absorbers. Application of the procedure is illustrated for the standardization of ^{35}S and ^{204}Tl. (auth)

37228 REGISTRATION OF FISSION-FRAGMENT TRACKS IN SEVERAL SUBSTANCES AND THEIR USE IN NEUTRON DETECTION. M. Debeauvais (Laboratoire de Physique Corpusculaire, Strasbourg), M. Maurette, J. Mory, and R. Walker. Intern. J. Appl. Radiation Isotopes, 15: 289-99(May 1964).

In a number of substances energetic, heavy charged particles leave trails of radiation-damaged material that can be selectively attacked by chemical reagents to produce tracks visible in an optical microscope. A comparative study was made of the density and length distribution of such tracks produced by uranium fission fragments in several micaceous minerals, Makrofol (a polycarbonate polymer) and glass. By comparing the track densities with those measured in nuclear emulsions it was concluded that fission fragments are registered with 100% efficiency in the micaceous minerals and in the Makrofol, but only with 40% efficiency in the variety of glass that was studied. The results are shown to be consistent with the hypothesis that the average rate of energy loss of the charged particle determines the ability to form etched tracks. It was previously pointed out that mica in combination with a fissile cover material has some signal advantages as a neutron detector. Several aspects of this application, including the measurement of track yields from thick uranium source, are discussed. (auth)

37229 INVESTIGATION OF RADIATION STABILITY OF CATION EXCHANGE CARBOXYLIC RESIN KB-6. E. D. Kiseleva, K. V. Chmutov, M. M. Klientovskaya, and A. B. Pashkov (Inst. of Physical Chemistry, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Khim., No. 6, 990-6(June 1964). (In Russian)

Ionite KB-6 showed different radiation stabilities in the H^+, Na^+, and Cu^{2+} forms. Irradiation of the H^+ and Cu^{2+} forms in water and of the Na^+ form in the dry state to doses of 0.2 to 1.8×10^{23} ev/g did not change the exchange properties significantly. Irradiation of the Na^+ form in water to the same dose decreased the capacity and increased the swelling. The suggestion is made that in irradiation in the dry state in an atmosphere of nitrogen bonds are ruptured and the ion exchange group is broken off with formation of carboxyl or phenyl-carbohydrate chain radicals. In the presence of oxygen, peroxide radicals are formed. (ICC-M.G.)

37230 ENERGY-DISTRIBUTION FUNCTION FOR HOT ATOMS PRODUCED BY NUCLEAR TRANSFORMATIONS. Chi-hua Hsiung, Kenneth L. Verosub, and Adon A. Gordus (Univ. of Michigan, Ann Arbor). J. Chem. Phys., 41: 1595-1600(Sept. 15, 1964).

The energy-distribution function for hot atoms produced by nuclear transformations was examined in terms of the fraction of the initial hot-atom energy. Energy dependent and independent asymmetric scattering is specifically considered. For gaseous tritium generated by the $^3He(n,p)$ process, the asymptotic solution probably can serve as a reasonable approximation of the distribution function in the energy range 2–20 ev. For hot atoms produced with an initial distribution of energies, such as $^{79}Br(n,\gamma)$-produced ^{80}Br, the asymptotic solution will be less valid than for tritium, but may still be a valid approximation. (auth)

37231 GAS-PHASE PHOTOLYSIS OF METHYL IODIDE. REACTIONS OF HOT METHYL RADICALS WITH ADDED ORGANIC COMPOUNDS. Richard D. Doepker and P. Ausloos (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 41: 1865-71(Sept. 15, 1964).

The photolysis of CH_3I and CD_3I at 2537 and 3130 Å was investigated in the presence of CD_3CH_3, C_2D_6, $CH_3CD_2CH_3$, $CD_3CH_2CD_3$, $C_4H_{10}-C_4D_{10}$ (1:1) mixtures, $(CH_3)_3CD$, $(CH_3)_3CCD_3$, C_6H_6, C_6H_{12}, CH_3OCH_3, CH_3COOCD_3, CD_3OH, C_2D_5OH, and CD_3CH_2OH. All mixtures were saturated with iodine in order to prevent the formation of methane by the reaction of thermal methyl radicals. It is shown that, under these conditions, the measured quantum yield of methane formation can be considered to be the probability that a hot methyl radical with 32 kcal will react with CH_3I or the additive. Intramolecular and intermolecular isotope effects are found to be of minor importance. The probability of abstraction of an H or a D atom from a molecule by a hot methyl radical increases with the number of available H or D atoms, or with a decrease in the ΔH of the reaction. For instance, it is seen that the relative probabilities per atom for abstraction of a primary, secondary, or tertiary H atom in a hydrocarbon molecule are 1:3.6:10.0. A variation in wavelength, from 2537 to 3130 Å, lowers the methane quantum yield by a factor of 10 but does not greatly affect the relative probabilities of abstraction from different sites within a molecule. The quantum yield of methane in the photolysis of CH_3I or CH_3I–hydrocarbon mixtures is nearly twice that observed for CD_3I or the corresponding CD_3I–hydrocarbon mixtures at the same wavelength. It was concluded that systematic studies of this type may prove to be useful in determining a priori the probability of reaction with other related organic compounds. (auth)

37232 EFFECT OF IMPURITIES ON THE F BAND IN KCl. G. A. Noble and J. J. Markham (Illinois Inst. of Tech., Chicago). J. Chem. Phys., 41: 1880-1(Sept. 15, 1964).

Samples of KCl crystals were colored by exposure to a 1000 Ci. ^{60}Co source at room temperature and analyzed by semiquantitative spectrographic analysis (SQSA). The results indicated that more measurements with the application of statistics would not reveal new relationships. If there are impurity effects they are of the same magnitude as the ordinary measurement errors. The analyses indicated that the problem of reducing the impurities remains. It was concluded that previous published values that characterize the F band in KCl must be accepted as reliable. (P.C.H.)

37233 THE RADIATION-INDUCED ADDITION REACTION OF ETHERS TO CHLOROFLUOROOLEFINS. Hiroshige Muramatsu, Kan Inukai, and Teruo Ueda (Government Industrial Research Inst., Nagoya, Japan). J. Org. Chem., 29: 2220-3(Aug. 1964).

The radio-induced addition reactions of tetrahydrofuran, dioxane, and diethyl ether to chlorofluoroolefins such as 1,2,2-trichloro-2-fluoroethylene, 1,2-dichloro-1,2-difluoroethylene, and 1,1-dichloro-2,2-difluoroethylene were carried out. While the addition of tetrahydrofuran and dioxane gave mainly 1:1 adducts in appreciable yields, diethyl ether added to the olefins to give a 1:1 adduct and a 1:2 adduct in a molar ratio of about 1:1. The structures of the adducts were determined by proton nmr spectroscopy. (auth)

37234 THE RADIATION-INDUCED ADDITION REACTION OF DIALKYL PHOSPHONATES TO CHLOROFLUOROOLEFINS. Kan Inukai, Teruo Ueda, and Hiroshige Muramatsu (Government Industrial Research Inst., Nagoya, Japan). J. Org. Chem., 29: 2224-6(Aug. 1964).

The radioinduced addition reactions of dialkyl phosphonates (methyl, ethyl, and n-propyl) to chlorofluoroolefins such as 1,2,2-trichloro-1-fluoroethylene, 1,2-dichloro-1,2-difluoroethylene, and 1,1-dichloro-2,2-difluoroethylene were made to give the corresponding dialkyl chlorofluoroethylphosphonates. The phosphonates were hydrolyzed to the chlorofluoroethylphosphonic acids and converted to the chlorofluoroethylphosphonic dichlorides. The chlorofluoro-

ethylphosphonic acids have an acidity similar to the ω-hydroperfluoroalkylphosphonic acids and perfluoroalkylphosphonic acids. (auth)

37235 THE $I^{1/2}$ RULE IN THE RADIOLYSIS OF SULFURIC ACID. L. T. Bugaenko and Kuang-lin Huang. Kinetika i Kataliz, 5: 550-1(May 1964). (In Russian)

In the case of homogeneous distribution of radicals in the radiolysis of dilute aqueous solutions of H_2SO_4 the yield of radical acceptors has been shown to be linearly dependent on the square root of the radiation dose rate. To determine whether or not this rule holds for other solutions, the yield of oxidized iron in 17.3M H_2SO_4 was studied in the presence of oxygen. At radiation doses of 5.25×10^{14} and 6.80×10^{14} ev/ml · sec, the yield of oxidized iron was independent of both dose rates and initial iron concentration for values $>2 \times 10^{-3}$M. Below this concentration the yield was lower and the reaction faster for the higher dose rate. A plot of the data shows that the $I^{1/2}$ rule holds. (ICC-M.G.)

37236 INVESTIGATIONS IN THE FIELD OF THE RADIATION-INDUCED SOLID STATE POLYMERIZATION. IV. THE INFLUENCE OF ADDITIVES ON THE SOLID STATE POLYMERIZATION OF N-VINYL-SUCCINIC-IMIDE. Gyula Hardy and József Varga. Magy. Kem. Folyoirat, 70: 258-64(June 1964). (In Hungarian)

The influence of additives of various types on the solid state polymerization of N-vinylsuccinimide was investigated by means of differential thermal analysis. Radical acceptors, as inhibitors (benzoquinone, diphenylpicrylhydrazyl) and monomers (acrylamide, maleic anhydride, and vinylpyrrolidone) increase the rate of solid state polymerization of N-vinylsuccinimide. The results indicate that in these systems the occurrence of the polymerization reaction is influenced primarily by the physical state (structure) of the matrix and less by the chemical reactivity. (auth)

37237 PRODUCTION AND POSSIBLE USES OF ^{18}F ISOTOPES. Ágnes G. Nagy and Klára Berei (MTA Központi Fizikai Kutató Intézet, Budapest). Magy. Tud. Akad. Kem. Tud. Oszt. Kozlemen., 21: 299-311(Apr. 6, 1964). (In Hungarian)

A brief review of the currently known methods of radiofluorine production is given with emphasis on ^{18}F. It is pointed out that a close cooperation in shipping arrangements between producer and user of this isotope is necessary because of the short half life. A method for ^{19}F production is described in which lithium carbonate was melted onto the walls of a quartz container, sealed under vacuum, and irradiated under 10^{13} n/cm^2/sec. It was then dissolved in nitric acid and the ^{18}F precipitated by $Ca(OH)_2$. The precipitate was dissolved in concentrated sulfuric acid, and the $H^{18}F$ evolved was passed into a collector containing 0.1N NaOH. One g Li_2CO_3 produced 7 to 8 mC ^{18}F with 3.6 to 3.8 mC/g Li_2CO_3 activity. The process could be completed in 70 to 80 min. Radiochemical purity of the sample was measured and checked by its γ spectrum. The expected impurity of ^{24}Na was always present in the sample. Uses of ^{18}F include: analytical chemistry, medical diagnoses, chemical structure determination, exchange reactions, and catalysis, biology, and biochemistry studies, particularly in protein chemistry and for studying the role of fluorine ion in enzyme inhibition. (TCO)

37238 X-RAY SCATTERING BY IRRADIATED SINGLE CRYSTALS OF POTASSIUM PERMANGANATE. E. G. Prout and M. E. Brown (Rhodes Univ., Grahamstown, South Africa). Nature, 203: 398-9(July 25, 1964).

In an attempt to determine the nature of radiation damage in potassium permanganate, x-ray-diffraction investigations were made on heavily irradiated (500 MRads) single crystals. The following lattice expansions were found: a, 0.21%; b, 0.31%; c, 0.45%. No observable artificial temperature factor was apparent, but pronounced diffuse scattering was present. It is suggested that the observed effects are due to the breaking of the Mn–O bonds in MnO_4 with the production of oxygen vacancies and oxygen interstitials. (P.C.H.)

37239 SYNTHESIS OF DEOXYADENOSINE UNDER SIMULATED PRIMITIVE EARTH CONDITIONS. Cyril Ponnamperuma and Patricia Kirk (Ames Research Center, Moffett Field, Calif.). Nature. 203: 400-1(July 25, 1964).

An investigation showed that deoxyadenosine in appreciable yield may be synthesized by the use of conditions that appear to be far more likely to have occurred on the primitive Earth. It was found that the dehydration reaction needed to link the purine adenine and the sugar deoxyribose can be effected by the use of hydrogen cyanide. The reaction appears to be activated by uv light, but the deoxyadenosine is formed even in the absence of the uv light. However the function of the uv light appears to enhance the yield. No deoxyadenosine was detected in the absence of CN^- or $NH_4H_2PO_4$. (P.C.H.)

37240 ELECTRON SPIN RESONANCE SPECTRA OF γ-IRRADIATED ALKOXIDES. J. E. Bennett (Shell Research Ltd., Chester, Eng.). Nature, 203: 514-15(Aug. 1, 1964).

The electron spin resonance spectra of gamma irradiated samples of sodium and potassium methoxides, ethoxides, and isopropoxides were observed over a temperature range from −196°C to 100°C. In all cases the resolution increased as the temperature was raised from −196°C. The spectra were interpreted logically as arising from the radicals $CH_2\bar{O}$, $CH_3CH\bar{O}$, and $(CH_3)_2C\bar{O}$, respectively, the last being the ketyl radical of acetone. Results on the isopropoxide confirmed the prediction that the hyperfine splitting constant of the ketyl radical $(CH_3)_2C\bar{O}$ should be a few oersteds smaller than that of the isopropanol radical $(CH_3)_2COH$. (P.C.H.)

37241 NEODYMIUM FLUORESCENCE IN THE 5 TO 6 MICRON REGION. F. Varsanyi (Bell Telephone Labs., Murray Hill, N. J.). Phys. Letters, 11: 193-4(Aug. 1, 1964).

Strong fluorescence between 5 and 6 microns was observed in $PrCl_3(Nd^{3+})$ crystals exposed to a tungsten lamp. Nine spectral lines were identified and were determined to originate from $^4I_{13/2}$ and $^4I_{11/2}$ states. (D.C.W.)

37242 SCINTILLATION CHARACTERISTICS OF ANTHRACENE AND NAPHTHALENE CRYSTALS IN BOMBARDMENT WITH α-PARTICLES, DEUTERONS, AND ELECTRONS AT LOW TEMPERATURES. Werner F. Kienzle (Universität, Göttingen, Ger.). Z. Naturforsch., 19a: 756-67(June 1964). (In German)

The scintillation response of anthracene crystals was investigated with 7.0-Mev α particles in the temperature range 1.5°K < T < 300°K and with 46-Mev α particles and 24-Mev deuterons in the temperature range 11°K < T < 300°K. With decreasing crystal temperature the scintillation light yield increases towards a temperature independent but still angularly dependent limiting value reached at about 4°K. The angular dependence of the scintillation light yield shows a so far unknown sharp peak at particle impact directions nearly parallel to the (a, b) plane. The

peak changes with crystal temperature and ionization density in a complicated manner and disappears below 10°K. For 0.6-Mev β particles the scintillation light yield was investigated in the temperature range 11°K < T < 300°K. It increases with decreasing temperature less steeply than the α-light yield, i.e., the α/β yield ratio increases as the crystal temperature decreases. From this it is concluded that the quenching of excitations within an ionization column is a function of the crystal temperature. Similar results were obtained with single crystals of naphthalene. A possible relation between the scintillation anisotropy and the anisotropy of the lattice thermal conductivity was examined. (auth)

37243 KINETIC ANALYSIS OF COMPLEX PHOTOCHEMICAL REACTIONS. Heinz Mauser (Universität, Tübingen, Ger.). Z. Naturforsch., 19a: 767-70(June 1964). (In German)

The principles for a method of kinetic analysis of photochemical reactions are described. For the analysis, differential equations are not fitted by the mass data and are not explicitly solved. However, the method can be applied to complicated reactions (secondary reactions, parallel reactions, etc.). (tr-auth)

37244 REACTII CHIMICE INDUSE DE RADIATIILE IONIZANTE. (Chemical Reactions Induced by Ionizing Radiation). Silvia Ionescu. Publishing House of the Academy of Rumanian National Republic, 1963. 264p.

One of the fundamental problems involved in the peaceful application of nuclear energy is represented in the manufacture of industrially important materials by exposing special starting materials to high levels of radiation. This resulted during the last decade in the sudden growth of radiation chemistry and its industrial application, based on the use of large radiation sources, such as chemonuclear reactors, electron and other particle accelerators and γ-radiation sources. In view of the economic importance of this problem for the fabrication of novel materials with unique properties, the theoretical and experimental principles involved are discussed in the 7 chapters of the book. The subjects covered include: interaction of radiation with matter; radioinduced chemical reactions; methods used for detecting the new species created by irradiation; laboratory-scale and industrial radiation sources; radiation dosimetry; inorganic and organic reactions; and finally actual and potential industrial applications. In the last chapter, the manufacture of HNO_3, the synthesis of hydrazine, and the effect of radiation on the oxidation of SO_2 are described, together with purification methods of petroleum hydrocarbons, alkylation, condensation and isomerization reactions, chlorination and oxidation of benzene, polymerization of vinyl chloride, oxidation of paraffins, reticulation of polyethylene films, sterilization and conservation of foodstuffs, and other radiation-induced chemical processes which are discussed. (TTT)

37245 POLYMERS. R. W. King, N. J. Broadway, R. A. Mayer, and S. Palinchak. p.84-166 of "Effects of Radiation on Materials and Components." New York, Reinhold Publishing Corp., 1964.

A review is presented on radiation effects of polymers, including plastics, thermoplastic resins, elastomers, polymeric components, sealants, seals and gaskets, tires, and transparencies. Two reactions are considered: crosslinking and degradation. 100 references are included. (P.C.H.)

37246 FUELS AND LUBRICANTS. S. L. Cosgrove (Univ. of Cincinnati). p.167-203 of "Effects of Radiation on Materials and Components." New York, Reinhold Publishing Corp., 1964.

A review is presented on the effects of nuclear radiation on: jet fuels; lubricating oils and hydraulic fluids; greases; and dry-film lubricants. Emphasis is placed on radioinduced changes in thermal stability and radiosensitivity. (P.C.H.)

37247 ORGANIC COMPOUNDS. Robert E. Wyant. p.204-76 of "Effects of Radiation on Materials and Components." New York, Reinhold Publishing Corp., 1964.

Radioinduced chemical changes in pure organic target materials are reviewed in terms of the chemical nature and yield of radiolysis products (G-values). Compounds discussed include: aliphatic hydrocarbons, aromatic hydrocarbons, esters, alcohols, halogen-containing compounds, amines, aromatic amines, heterocyclic nitrogen compounds, nitro compounds, aldehydes, ion exchange resins, organic heat-transfer materials, refrigerants, organometallic compounds, and organic dyes. 281 references are included. (P.C.H.)

37248 METHOD OF INHIBITING UNDESIRABLE RADIOACTIVE LABELING AND RADIATION DAMAGE IN SYSTEMS CONTAINING MATERIAL UNDERGOING RADIOACTIVE DECAY. Kang Yang and Preston L. Gant (to Continental Oil Co.). U. S. Patent 3,143,509. Aug. 4, 1964. Filed Mar. 15, 1961.

A method is given for inhibiting the formation of undesirable products due to decay of labeled compounds, more particularly the formation of tritium-labeled methane in stored tritium-labeled compounds. The method, which is based on the discovery that free radicals are important in the decomposition, comprises adding a radical-scavenging compound to the labeled compound. The efficacy of the method is illustrated by two examples in which butadiene and NO respectively are used to suppress decomposition of tritiated propane and contamination of tritium. (D.L.C.)

Separation Processes and Procedures

Refer also to abstracts 37407, 37414, 37420, 38255, and 38684.

37249 (A/CONF.28/P/56) DEVELOPMENT OF THE URANIUM INDUSTRY IN FRANCE. Pierre Magnet (Commissariat à l'Energie Atomique, Paris), Paul Vertes, and Frances Bazile. May 1964. 14p.

The main feature in the development of the French uranium industry during the last few years is the completion of the program, already started in 1958, for the equipment of mining units and treatment plants. It was thus possible by 1961, to reach a production capacity of about 2000 tons of metal contained in concentrates, and about 1800 tons of metal of nuclear purity. The prospecting and research carried on in France by the CEA and by private industry have brought about not only a satisfactory renewal of the reserves under exploitation but also the development of two new uranium-producing regions: one of the usual type in France, in the crystalline formations to the South-East of the Massif Central, the other in the Permian sedimentary formations in the department of l'Hérault. Ore extraction is essentially taken care of by the CEA in the three mining districts Vendée, Limousin and Forez, private industry having been unable to form any large production unit under the conditions prevailing in recent

years. Physical methods of concentration have been gradually abandoned, with the exception of a continuous radiometric sorting at the Bessines plant and the gravimetric concentration of uranothorianite ores at Madagascar. (auth)

37250 (A/CONF.28/P/61) RESEARCH ON PROCESSES FOR THE CONVERSION OF URANIUM COMPOUNDS WITH HIGH ISOTOPE ENRICHMENT — DESIGN AND CONSTRUCTION OF A TREATMENT PLANT. Pierre Nollet and Pierre Sarrat (France. Commissariat a l'Energie Atomique, Paris). May 1964. 14p.

The enriched uranium workshops in Cadarache have a double purpose: to convert uranium hexafluoride into metal or oxide, and to recover the uranium in scrap materials. The principles adopted for the design and safety of these workshops are reported. The uranium hexafluoride of high isotopic enrichment is converted either by injection of the gas into ammonia or by direct hydrogen reduction to uranium tetrafluoride. (auth)

37251 (A/CONF.28/P/98) LONG-TERM PROSPECTS OF IRRADIATED NATURAL URANIUM PROCESSING COSTS. OPTIMUM PLANT SIZES AND SITES. Lucien Thiriet (France. Commissariat à l'Énergie Atomique, Paris); Claude Oger, and Pierre de Vaumas. May 1964. 13p.

A program for natural uranium reprocessing plants associated with gas-cooled, graphite-moderated power reactors is discussed. Long-term prospects of reprocessing costs, a study of the optimum sizes and sites for the plants, and possibilities of expansion of methods are considered. (R.E.U.)

37252 (A/CONF.28/P/100) RECENT PROGRESS IN FISSION-PRODUCT SEPARATION. Andre Raggenbass (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 7p.

Separation processes for fission products to provide low-cost radiation sources for industrial and research applications are discussed. Cesium-137 removals from solutions prepared from nonalloyed U, from U–Mo alloys, and by ion exchange are discussed. Strontium-90 and rare-earth removal by solvent extraction using di-2-ethylhexylphosphoric acid is discussed. (R.E.U.)

37253 (A/CONF.28/P/159b) FUEL CYCLE COSTS FOR A LARGE NUCLEAR POWER PROGRAMME. ECONOMIC CHARACTERISTICS OF PROCESSING FACILITIES. N. L. Franklin (United Kingdom Atomic Energy Authority. Production Group, Risley, Lancs, England), C. Allday, J. L. Gillams, and D. G. Avery. May 1964. 8p.

The scale-dependent characteristics of the main processes of fuel reprocessing are discussed as an extension of paper A/Conf.28/P/159a, which considers fuel cycle costs from Magnox, AGR, and SGHW reactors. (R.E.U.)

37254 (A/CONF.28/P/160) THE DEVELOPMENT OF THE NEW SEPARATION PLANT, WINDSCALE. B. F. Warner, W. W. Marshall, A. Naylor, and G. D. C. Short (United Kingdom Atomic Energy Authority. Production Group, Risley, Lancs, England). May 1964. 15p.

The evolution of the process and the techniques used in establishing the performance of the Windscale separation plant for plutonium extraction from natural uranium are described. The specification of the process and products are given, and against these the relative merits of various processes are discussed. Reasons are given for the decision to install a mechanical decanning unit and a 3-cycle, 20% tri-n-butyl phosphate in odorless kerosene extraction system, in which uranium and plutonium are separated in the second cycle. Factors affecting the choice of ion-exchange or solvent-extraction processes for the plutonium purification cycles are also described. The influence of effluent disposal on process selection is emphasized, the implications of solvent degradation briefly discussed, and the principal problems and methods of control of nuclear safety in the plant are summarized. The techniques used in establishing the selected process and equipment in an economical manner are described in the sequence of computation of the flowsheet, selected laboratory studies, pilot plant trials, and equipment tests. Specific chemical problems discussed include uranium-plutonium separation, solvent washing, and solvent degradation. The procedures used for the development and testing of solvent extraction flowsheets on a miniature pilot plant, which closely duplicates process conditions on the large-scale plant, are described. The basic principles of the mechanical decanning unit and the methods used in design and development of the mixer-settler units selected for the process are described. It is concluded that the process and plant is capable of flexible and economic operation with considerable potential increase in throughput both for natural-uranium and low-enrichment (e.g., A.G.R.) fuels. (auth)

37255 (A/CONF.28/P/161) THE NEW SEPARATION PLANT WINDSCALE: DESIGN OF PLANT AND PLANT CONTROL METHODS. H. Corns (United Kingdom Atomic Energy Authority. Engineering Group, Risley, Lancs, England), D. W. Clelland, T. G. Hughes, and J. W. de Lisle Nichols. May 1964. 15p.

The design philosophy applied to the new plant is described, and an outline is given of the main considerations in siting, layout, activity segregation, nuclear safety, maintenance, ventilation, shielding, and containment. A description of the plant is given for the various operations of fuel cooling, decanning, dissolving, solvent extraction operations, thermal denitration, and liquid waste disposal. The essentials of plant operation are discussed together with the principal methods of plant control used. This is followed by a discussion of instrument requirements and mention is made in particular of new instrument features that were incorporated in the design. (auth)

37256 (A/CONF.28/P/344) EXTRACTION PROCESSING FOR THE IRRADIATED FUELS BY USING THE SOLUTION OF TRIBUTYL PHOSPHATE IN CARBON TETRACHLORIDE. M. F. Pushlenkov, V. G. Shumkov, V. I. Zemlyanukhin, B. Ya. Zilberman, O. N. Shuvalov, V. G. Voden, and N. N. Shchepetilnikov (U.S.S.R.). May 1964. 15p.

The pilot-plant processing of solutions of irradiated fuel elements from power reactors by using 1.1 M TBP solution in CCl_4 is considered. Choice of the flowsheet and the operation order are explained. The flowsheet consists of one circuit for simultaneous extraction of uranium, plutonium, and neptunium, two uranium and two plutonium circuits, one neptunium circuit, processing for aqueous raffinate solutions, and an extractant regenerator. Much attention was given to recycling solutions. The decontamination factors for fission products limiting the extraction process (Zr, Ru, R.E.) are given by the processing stages. (auth)

37257 (A/CONF.28/P/345) EXTRACTION-CHROMATOGRAPHIC ISOLATION OF AMERICIUM AND CURIUM. V. M. Vdovenko, A. S. Krivochatskii, M. P. Kovalskaya, E. A. Smirnova, S. M. Kulikov, N. A. Alekseeva, and L. M. Belov (U.S.S.R.). May 1964. 22p.

Methods for the separation of Am and Cm from nitric-acid solutions of Mg-ceramic fuel blocks were investigated. The actinides are first separated from the macrocomponent by extraction. Then Pu(IV) is extracted using TTA. The subsequent separation of fission rare earths from the Am and Cm was studied by extraction from LiCl solutions using D2EHPA and TDA chloride in different diluents. A chromatographic method of purification is described to separate remaining impurities, mainly lanthanides. (M.J.T.)

37258 (A/CONF.28/P/346) EXTRACTION PROCESSES AND THEIR MATHEMATICAL DESCRIPTION. A. M. Rozen, A. I. Bezzubova, B. V. Elatomtsev, et al. (U.S.S.R.). May 1964. 24p.

Work was undertaken to investigate and quantitatively interpret the regularities of extraction processes: extraction equilibria, material distribution in multi-stage radiochemical extractors, mass-transfer processes. The equilibrium study includes the investigation of the effects of extractant composition and structure, salting-out-agent, and diluent influence on the extraction of some actinides by neutral phosphororganic compounds. An attempt was made to establish the quantitative relation between the extractability and the solvent structure. The free energy for the extraction of actinides was found to depend approximately linearly on the effective electronegativity sum of functional groups, forming part of the extractant. The extraction specific feature, i.e., a relatively weak basic chemical interaction between the extracted species and the extractant requires that contribution of both the electrostatic and Van der Waals' interactions to the chemical potential should be taken into account, i.e., the solution theory should be used. Thus, taking into consideration the electrostatic forces and hydration in terms of electrolyte solution theory, it is possible to interpret theoretically and describe quantitatively the effect of salting-out-agents (it being sufficient to know the ionic diameter and hydration numbers of the compound and salting-out-agent). The quantitative description of the diluent effect is attained using the theory of multicomponent non-electrolyte solutions. The necessity to consider pair interactions between all the components of the organic phase (dissolvent, extractant, metallic solvate, water, HNO_3) is revealed. The interactions are investigated by measurements of the activity coefficients in binary systems. Physicochemical interpretation of the deviations observed from the ideality and their influence on the extraction are given. Extraction cascade regularity study includes techniques for the calculation of material distribution on cascade stage, the determination of recovery and decontamination in the extractors, having different flow-sheets, and with combination of an extraction performance and the optimization methods are discussed; it is shown that the influence of change of different parameters (flow, concentration) can be described in terms of a variation of one generalized parameter – the degree of approximation to the limiting condition. The optimization of the extraction conditions is attained by using criteria which characterize the importance of the decontamination factors, valuable component losses and internal accumulation of elements during reprocessing of different materials. Experimentally determined and computed static and dynamic characteristics of extractors are discussed. The general regularities of mass-transfer are changed by the non-ideality of solutions and non-linearity of distribution isotherms (e.g., typical of extraction of actinides by TBP). The inconstancy of distribution coefficients does not permit to eliminate the interface concentrations from the expressions for diffusion flux by a simple procedure; in view of this the typical equation for mass-transfer becomes incorrect. A more general equation is deduced with the regard of the diffusion flux being proportional to the chemical potential gradient rather than to the concentration gradient. Some other possibilities of the elimination of interface concentrations are reviewed; mass-transfer data for extraction of uranium by TBP are interpreted. The discussion is given of some problems of hydrodynamics and mass-transfer from single drops and in the extractors as well as of the criteria facilitating the data correlation. The mechanism of extractor intensification is elucidated. The effect of the longitudinal mixing and the transverse non-uniformity on the extractor efficiency is considered, and the additivity limits of effects are established. The possibilities of extractor calculation are discussed. (auth)

37259 (A/CONF.28/P/347) EXTRACTION OF SOME ELEMENTS WITH PHOSPHOROUS-CONTAINING MONOBASIC ACIDS. E. S. Gureev, Z. M. Karpacheva, M. N. Ryzhov, V. S. Smelov, E. G. Teterin, V. G. Timoshev, and I. K. Shvetsov (U.S.S.R.). May 1964. 20p.

An investigation was conducted of the extraction mechanism of some elements (U, Np, Pu, Cs, etc.) with acidic phosphororganic compounds and of the effects of the structure and composition of these compounds on their solvent properties. The mechanisms studied were the cation-exchange and solvate mechanisms. The variables in the compounds studied were the radical length, number of oxygen atoms (in going from phosphine oxide to phosphates), aromatic radicals, electronegative groups, diluent, etc. (D.L.C.)

37260 (A/CONF.28/P/348) METHODS OF RECOVERY AND SOME CHEMICAL PROPERTIES OF TRANSPLUTONIUM ELEMENTS. E. S. Gureev, V. B. Dedov, S. M. Karpacheva, I. A. Lebedev, I. K. Shvetsov, G. N. Yakovlev, M. N. Ryzhov, and P. S. Trukchlaev (U.S.S.R.). May 1964. 20p.

To produce transplutonium elements for relatively short periods of time the SM-2 reactor with the 2.10^{15} $n/cm^2/sec$ flux in the central channel was built. There is a large radiochemical laboratory in the reactor building where transplutonium elements including Es and Fm are being extracted and their properties studied. The laboratory is equipped with 16 cells and 56 boxes. In the chambers and in the boxes the experiments with the activity up to 100,000 C can be carried out. The total effective area of the laboratory is 20,200 m^2. The extraction of transplutonium elements is accomplished by separating them from a great number of fission products and first of all of rare earth elements whose chemical properties are essentially similar. The extraction properties of these elements with neutral and phosphorous-organic acid compounds from water-salt solutions were studied. The complex formation constants of some transplutonium and rare earth elements with phosphorous-organic compounds, mineral acids, and a number of other compounds were determined. Under the static and dynamic conditions the investigations of extractive separation of transplutonium and rare earth elements by phosphororganic acid compounds and amines from chloride and rhodanide solutions were carried out. Using these extractants a number of technological schemes of transplutonium element extraction with high yield and practically complete purification of these elements from fission products were obtained. (auth)

37261 (A/CONF.28/P/414) INDUSTRIAL APPLICATION OF CATALYTIC PRECIPITATION OF URANIUM.

B. Bunji, B. Zogovic, R. Crnojevic, N. Pacovic, and M. Secerov (Institute of Nuclear Raw Materials, Belgrade). May 1964. 15p.

Recent investigations have verified that the reduction of U(VI) to U(IV) is a catalytic one in which the selection and form of catalyst have a large influence on the feasibility of the process. It has been demonstrated that the process of reduction of U(VI) to U(IV) from the water solutions of sodium carbonate is best carried out with UO_2 as a catalyst, which is at the same time produced by the reaction itself. Laboratory and pilot plant experiments with nickel wire pointed out that the uranium oxide is deposited on the surface of the wire. The thickness of the deposited oxide ranged up to and more than 5 millimeters, and the density ranged from 4 to 5 g/cm^3. The process of reduction was developing with catalyst deposited in this way. To check catalytic abilities of uranium dioxide without the presence of nickel wire the reduction process has been studied and the results of the application of uranium-dioxide in the form of powder and Raschig rings have been demonstrated. The activation of catalyst at the increased temperature in hydrogen stream has been illustrated. This kind of activation enables the application of such catalyst for the precipitation of uranium from the alkaline solutions at a temperature below 100°C, at normal hydrogen pressure. Based on the results of the laboratory pilot plant experiments, the construction of full scale plant for continuous uranium precipitation from carbonate leaching solutions has been undertaken. The description of the plant and the basis for the selection of processing, together with results and analysis, was also presented. The effect of precipitation of uranium as a function of the application of uranium dioxide as a catalyst retention time, concentration of agents and uranium, method of agitation, temperature and pressure has been analyzed. (T.R.H.)

37262 (A/CONF.28/P/418) A REPROCESSING ALTERNATIVE FOR ZIRCALOY-CLAD NATURAL OR SLIGHTLY ENRICHED URANIUM OXIDE FUEL ELEMENTS. E. Haeffner, A. Hultgren, and A. Larsson (Aktiebolaget Atomenergi, Stockholm). May 1964. 15p.

The reprocessing method described is intended for the treatment of uranium oxide fuel canned in zirconium alloys and irradiated to a burn-up of the order of 10,000 Mwd/t. The decanning is carried out by high temperature oxidation of the zirconium followed by a dissolution of the oxide core in nitric acid. Plutonium is separated from the uranium and fission products by an amine extraction process. The uranium is decontaminated to an adequate degree with tributyl phosphate extraction. An economic evaluation of a plant of 1 t/day capacity is made. (auth)

37263 (A/CONF.28/P/433) COMMERCIAL TECHNICAL METHODS FOR RECONCENTRATION AND PURIFICATION OF DEGRADED AND CONTAMINATED HEAVY WATER FOR NUCLEAR REACTORS. Tatsuo Saito (Showa Denko K. K., Tokyo), Susumu Sonoda, Yasuo Kurihara, Takeichiro Takamatsu, and Tokuyoshi Morita. May 1964. 20p.

Pilot plant tests were made on the non-diaphragm electrolysis process with special recovery apparatus, and the rectification process, and established new, workable techniques in both processes. New technology was completed including necessary conditions to scale up apparatus (Japanese Patent No. 256416, Japanese Utility Models No. 714723 and No. 714724), the optimum cascade theory, and economic evaluation. These processes are indispensable to improve the economy of the heavy water reactor. To prevent contamination and degradation of heavy water in treatment, the gas circulation and recovery system is of special design. The operating condition is very safe and the yield is about 100%. The distillation process consists of a sieve plate tower. The design is based on the ideal cascade theory, and the operation cost is very low. Appreciable service was performed in the operation of JRR-2 and JRR-3 of the Japan Atomic Energy Research Institute. New economic reconcentration and regeneration of heavy water is being carried out with a 5 T/Y plant. Results are given of experiment and design calculation of a 30 T/Y plant capable of treating larger quantities of heavy water. It is pointed out that the aforesaid electrolysis process is economically advantageous for a capacity of less than 5 T/Y and the rectification process for a higher capacity. Experience was also obtained in the removal of impurities in heavy water, including oil and soluble ion. (D.L.C.)

37264 (A/CONF.28/P/450) RECENT RESULTS IN THE PROCESSING OF HUNGARIAN URANIUM ORES. E. Szabo, L. Bakos, B. Czegledi, M. Fodor, and P. Mueller (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). May 1964. 21p.

Results achieved by research activities on problems in the processing of uranium ores are reported. Information is included on: mineralization and deposition studies, weight correction radiometers and optimum grain size for radiometric recovery procedures, reduction of loss due to leaching for uranium ores with carbonate content, extraction from eluates, and structural investigations of ammonium uranates and uranium oxide hydrates. (N.W.R.)

37265 (A/CONF.28/P/455) COEXTRACTION OF THORIUM AND CERIUM BY NEUTRAL PHOSPHORUS ORGANIC COMPOUNDS. Atif Alian (United Arab Republic. Atomic Energy Establishment, Inshas, Egypt). May 1964. 15p.

The separation coefficient of thorium and cerium is expressed in terms of the nitrate ion concentration in the aqueous phase, the free solvent concentration in the organic phase, and stability constants determined experimentally for TBP and DAMPK. Separation-constant values were calculated and found to agree with experimental results. (M.J.T.)

37266 (A/CONF.28/P/456) NUCLEAR-GRADE ZIRCONIUM FROM EGYPTIAN ZIRCON PLACERS. M. Y. Farah and I. S. El-Yamani (United Arab Republic. Atomic Energy Establishment, Inshas, Egypt). May 1964. 12p.

Manufacture of cladding Zircalloys implies starting with 98% ore and silica-free zirconia before dehafnization and metallurgical elaboration. Dehafnization of fed zirconia still containing 1.4% HfO_2 was studied. The usual organophosphorus and amine solvents were examined in view of enhancing maximum loading charge and introducing cheaper commercial varieties. Tributylphosphate as a 60% solution is suggested after examining numerous diluents (odorless kerosene, methyl isobutyl ketone, xylol, n-hexane, benzene, cyclohexane, toluene) besides white spirit. Examined variables were the time of contacting (1 to 5 min) and the concentrations of free nitric acid (5 to 8 molar), fed zirconium (5 to 100 gm/l, and salting-out agents (about 3.5 molar nitrates). Long-chain aliphatic and aromatic amines examined included: Armeen C,S,T, TD, and HTD of Armour Hess and FB-Amine 10, 12, 16, 17, and 18 of Float-Ore firm. Tri- and dibenzylamine, trilaurylamine hydrochlorides, and sulfate liquors were studied, and the effect of lowering temperature, increasing acidity, and changing diluents were examined. (auth)

37267 (A/CONF.28/P/484) DEVELOPMENTS IN THORIUM PRODUCTION TECHNOLOGY. K. J. Bril and P. Krumholz (Brazil. Instituto de Energia Atomica, São Paulo). May 1964. 17p.

Recent development in the processing of thorium-bearing ores and in the production of nuclear grade thorium oxide are reviewed with special reference to industrial and pilot plant experience in Brazil. The alkaline process for breaking up monazite, as practiced in Brazil since 1948 on an industrial scale, presents from the point of view of thorium recovery, considerable advantage over other methods. In particular, yields are practically quantitative, separation factors of thorium from rare earths and phosphate are of the order of 100, and thorium is obtained in a form very suitable for solvent extraction purification. Working conditions, which allow obtaining satisfactory results under economic conditions are presented. Solvent extraction purification of thorium is discussed with special emphasis on slurry extraction, thorium decontamination from rare earths and separation of thorium and uranium. (auth)

37268 (A/CONF.28/P/503) CHEMICAL TREATMENT OF URANIUM ORES AT THE MINES, IN A SEMI-MOBILE PLANT. J. Freire de Andrade, H. Carreira Pich, and F. Marques Videira (Portugal. Junta de Energia Nuclear. Laboratório de Física e Engenharia Nucleares, Sacavém). May 1964. 19p.

In the uraniferous area situated in the north-east of Portugal far from the only industrial uranium chemical treatment plant existing in the country, a few small dispersed deposits are found, each containing about 10 to 50 tons of uranium. The relatively small reserves and the dispersion of the deposits would not justify the building of a conventional plant in that area. For this reason studies were directed to develop an economical process of uranium concentration, involving equipment that might be easily moved from mine to mine. Studies were carried out with a view to reducing or eliminating bulky operations, such as grinding and liquid-solids separation. The treatment of the ores after a coarse crushing was tried. Bench scale studies were carried out, the two following processes having been tried: the ore was imbibed with a sulfuric acid solution, and after different periods of time was watered to remove soluble uranium; and the ore was sprinkled with a sulfuric acid solution, and later was watered to remove soluble uranium. These two processes were applied with encouraging results to several kinds of ores, with the exception of the alkaline and impermeable ores. In particular, the treatment of Forte Velho ore, which essentially consists of a weathered granitic rock with torbenite mineralization, was studied in great detail. In the laboratory experiments, from an ore containing 0.2% U_3O_8, ground to minus ½", placed in small columns, a recovery of 80% of the uranium was obtained, with an acid consumption lower than 25 kg per ton of ore. The results also suggested the advantages of recirculating the richer acid leach liquors through fresh ores, and of using higher columns in order to increase the contact time between the ore and the acid solution. Based on these experiments, a 35 ton/day pilot plant was designed. The plant has been running since May 1962. The uranium recovery has been about 75% in spite of frequent variations of characteristics and grade of the uranium ores being treated. The uranium concentrate contains about 75% U_3O_8. Details about the equipment and on operating costs are mentioned. Reference is also made to some problems concerned with the plant operation. (auth)

37269 (A/CONF.28/P/508) GUIDE FOR THE HAZARDS EVALUATION OF A CHEMI-NUCLEAR INSTALLATION. J. Tadmor and H. Galron (Israel. Atomic Energy Commission, Tel-Aviv). May 1964. 19p.

A study of the environmental hazards involved in the operation of a typical chemi-nuclear installation, based on the "maximum credible accident concept" is presented and compared with the environmental hazards of a nuclear reactor. General information required for a hazards evaluation study of a chemi-nuclear installation, which should be considered in planning the safety precautions for such plants, is discussed. Consideration is given to two safety concepts: nuclear and chemical safety. Among the topics on which information is required for the hazards evaluation study are the following: site evaluation; materials of construction and resistance of the installation to fire, pressure, and shock waves; auxiliary installations (ventilation, filtration, monitoring system, emergency systems, etc.); study of the different processes (chemical, metallurgical), of the conditions of operation (temperature, pressure, etc.), and of the materials involved and their properties (e.g., radioactivity, pyrophoricity); control system; maintenance and operation; storage, transportation, and waste disposal; shielding and containment; personnel organization and responsibilities; possible accidents (fire, explosion, criticality, earthquake, etc.) and their consequences; evaluation of hazards during normal and continuous operation and following accidents; and emergency procedures. Special consideration is given to various features of chemi-nuclear plants which differentiate them from nuclear reactors from the safety standpoint, such as high volume specific activity of materials, presence of inflammable and explosive materials, variety of operations involved, and the impossibility of providing the installations with the same degree of containment as in nuclear reactors. (auth)

37270 (A/CONF.28/P/512) ISOLATION OF FISSION FRAGMENT RADIOACTIVE ELEMENTS BY EXTRACTION. N. E. Brezhneva, G. V. Korpusov, E. N. Patrusheva, N. P. Prokhorova, and Yu. S. Krylov (U.S.S.R.). May 1964. 18p.

Neutral and acid phosphorus compounds were tested as extractants. A study was made on the mechanism of fission-product extraction as functions of nitric-acid concentration, fission products considered, and extractants. The most suitable extractant found was di(2-ethylhexyl) orthophosphoric acid. The process of separating fission products using this compound and TBP is described. (M.J.T.)

37271 (A/CONF.28/P/562) RESEARCH IN BRITISH UNIVERSITIES RELATED TO NUCLEAR FUEL REPROCESSING. G. R. Hall (Imperial Coll. of Science and Tech., London), F. L. D. Cloete, G. C. Coggan, et al. May 1964. 15p.

Research related to the chemistry and technology of nuclear fuel aqueous reprocessing is described. The breakdown of organic ion exchange resins when exposed to intense ionizing radiation was examined. Inorganic ion exchange materials are known to be more stable to radiation than organic resins. A quantitative examination of properties of Linde Molecular Sieve 13-X, a synthetic zeolite, shows a remarkably high radiation stability with respect to its structure, sorption, and cation exchange capacities. This material possesses certain excellent ion exchange properties but is unstable in solutions of pH lower than 5. The exchange equilibria of a variety of cation and anion exchangers based on hydrous zirconia and thoria and on zirconium and thorium phosphates are reported. High specificity can be attained, but commercial application is limited due to difficulties in preparing stable reproducible materials and to their limited stabilities in acid solution.

In studies of the chemistry of solvent extraction processes particular attention was given to acid and neutral phosphate solvents and to the amines tri-n-octylamine and methyldioctylamine. Data for the extraction of acids and metal anionic species into these solvents are reported. A number of complexes of NpO_2^+ and NpO_2^{2+} were identified. The electrolytic dissolution of uranium metal into nitric acid using a tubular dissolver is described. The new dissolver has several advantages over the more familiar basket dissolver. Recent theoretical studies on the dissolution of a cylindrical fuel element in a potential gradient are reported. The influence of dimensional scale-up and operating variables on the performance of pulsed columns and mixer-settlers using aqueous-dispersed systems are considered. An important aspect of this work was a fundamental study of coalescence. Some techniques for continuous countercurrent contact of particulate solids with fluids are described, including a novel technique particularly suitable for processes operating under highly radioactive conditions. Results are reported on the hydrodynamics and mass transfer performance of small-scale equipment operating on ion exchange systems. (auth)

37272 (A/CONF.28/P/637) THE SEPARATIVE POWER OF SHORT COUNTERCURRENT CENTRIFUGES. C. Ouwerkerk and J. Los (Reactor Centrum Nederland, [The Hague]). May 1964. 12p.

In general countercurrent centrifuges are operated as closed units, which are fed somewhere in the middle of the centrifuge, while at both ends the separated fractions are withdrawn. These centrifuges could be considered as the combination of a rectifying part and a stripping part. In a recent publication it was shown that a symmetrically operated countercurrent centrifuge has an efficiency that amounts to 80% of the maximum separative work that can be performed. It was shown that the decrease of the separative power is due to the fact that no optimal radial concentration gradient can be maintained along the length of the centrifuge. At both ends the radial concentration gradient approaches the equilibrium concentration gradient, because the net desired material transport approaches zero. The influence of the feed on the separative power is considered. In most experiments the feed has to be introduced in the forward stream of the countercurrent, thus giving rise to an asymmetry of the column parameters of the rectifying and the stripping part. This asymmetry can be corrected for only partially, by shifting the feedpoint upstream. It is shown that a further reduction of about 15% of the separative power results from this asymmetry. (auth)

37273 (A/CONF.28/P/703) URANIUM DIOXIDE PRODUCTION. A SURVEY OF ELECTROCHEMICAL REDUCTION AND PRECIPITATION FROM CARBONATE SOLUTIONS. V. Pravdic, M. Branica, and Z. Pucar (Institut "Rudjer Boskovic," Zagreb). May 1964. 14p.

Conditions for the electrochemical reduction of uranium(VI) in carbonate solutions to uranium(IV), and conditions for the subsequent precipitation of uranium dioxide (or hydrated oxides) are given and the obtained results discussed. On the basis of the results obtained, the flow sheet of a cyclic process is proposed. Two aspects of application are discussed: Production of uranium dioxide from ammonium diuranate by electrolysis of ammonium carbonate solutions of high uranium content; and extraction of uranium from ore leach liquors to obtain technical concentrates. Application to low grade ore leach solutions is considered also. (T.R.H.)

37274 (A/CONF.28/P/704) PRELIMINARY STUDY OF A FUEL REPROCESSING PILOT PLANT. B. Gaudernack (Norway. Institutt for Atomenergi, Kjeller), I. Gal, J. Falnes, E. Julsrud, and A. Ruvarac. May 1964. 18p.

A preliminary design study of a fuel-reprocessing pilot plant is described. The purpose of the reprocessing facility is to reprocess fuel of experimental reactors, to develop fuel reprocessing of a future power reactor, and to gain experience and technical know-how in the field of fuel reprocessing. The pilot plant is primarily designed for aqueous reprocessing of natural and/or low-enriched metallic uranium, canned in pure or alloyed aluminum or magnesium. However, oxide fuels in stainless steel or Zircaloy could also be treated by a chopping and leaching dissolution technique. The anticipated fuel burnup is 3000-7000 Mwd/t, and the cooling-time about 120 days. The nominal plant output is 1 kg U per hour, but if necessary, it can be increased. The basic chemical flowsheet is an adopted Purex process consisting of chemical (or mechanical) decanning and dissolution of fuel, two extraction cycles for uranium and plutonium, tail-end uranium purification, and auxiliary processes (i.e., waste treatment, acid and solvent recovery). (auth)

37275 (A/CONF.28/P/755) MISCIBILITY GAP IN EXTRACTION SYSTEMS INVOLVING ALKYLAMINES. A. S. Kertes and Y. E. Hobousha (Hebrew Univ., Jerusalem). May 1964. 20p.

A systematic study of miscibility gap phenomena in solvent extraction processes is presented. The systems studied include amine–diluent–HCl and amine hydrochloride–diluent–uranyl chloride–(HCl or LiCl). The amines used are tri-isooctylamine, tri-isosmylamine, and a mixture of tri-n-decylamine and tri-n-octylamine. The diluents include alkanes, cycloalkanes, naphtha, kerosene, ligroin, and isopropyl ether. In nearly all the experiments heterogeneity appeared as a clear liquid phase, which was ejected from an organic solution that was homogeneous prior to its equilibration with an aqueous solution. (T.F.H.)

37276 (A/CONF.28/P/758) EXTRACTION STUDIES ON SELECTED PROBLEMS IN REPROCESSING. J. van Ooyen (Reactor Centrum Nederland, Petten), R. Bac, M. Bonnevie-Svendsen, and H. Eschrich. May 1964. 15p.

The chemistry of Pu and Ru in nitric acid solutions was studied to furnish data for evaluation and improvement of Purex flow-sheet conditions, for Pu purification, and for development of analytical methods to be used at Kjeller for uranium reprocessing. Conventional extraction procedures and reverse-phase chromatography are considered. (R.E.U.)

37277 (A/CONF.28/P/760) CZECHOSLOVAC LABORATORY-LEVEL RESEARCH IN SPENT FUEL REPROCESSING. S. Havelka and M. Kyrs (Ceskoslovenska Akademie Ved. Ustav Jaderneho Vyzkumu, Rez). May 1964. 16p.

A survey is presented of the Czech research work carried out in the past 2 or 3 years on separation processes for spent fuel reprocessing. The following topics were studied: liquid-liquid extraction, ion exchange, coprecipitation, radiocolloids, and volatile fluorides. (D.L.C.)

37278 (A/CONF.28/P/761) OPERATIONAL EXPERIENCE FROM THE KJELLER REPROCESSING PILOT PLANT. B. Gaudernack (Norway. Institutt for Atomenergi, Kjeller), K. P. Lindland, and C. J. Joseph. May 1964. 13p.

The Norwegian-Dutch reprocessing pilot plant at Kjeller, Norway, since June 1961, has processed irradiated natu-

ral uranium fuel from the JEEP reactor at Kjeller. The following operations are carried out in the plant: mechanical decanning of the Al-clad fuel elements; dissolving of the decanned uranium metal in nitric acid; and liquid-liquid extraction of the uranium solution to separate uranium, plutonium, and fission products. The extraction is performed in three pulsed columns: the first for extraction of U and Pu and scrubbing of the extracted fission products; the second column for reduction and stripping of Pu and re-extraction of the U following the Pu product; the third column for U stripping. The capacity of the extraction columns is about 0.5-kg uranium per hour. Most extraction runs have lasted about 30 hours. Tributyl phosphate (TBP) diluted with kerosene was used as extractant. The maximum burn-up of the processed fuel was about 400 Mwd/ton and the minimum cooling time about 30 days. Various Purex-type flow-sheets were tested. The influence of varying feed and scrub acidities in the first column on the decontamination factors for Ru, Zr, and Nb was studied. Extractions with varying uranium concentrations in the feed solutions were performed. The use of 20 and 30% TBP as extractant was compared. Two series of test runs were performed for Eurochemic to evaluate the decontamination factors obtainable with Eurochemic's proposed flow-sheet for the first extraction cycle. In later experiments, ferrous sulfamate was replaced by tetravalent uranium as reductant for plutonium in the partitioning column. In some runs U(IV) was introduced in the top of the second column, in other runs in the middle of the column. Flow-sheets with varying U(IV)/Pu ratios were compared. The plutonium products resulting from the first cycle experiments was collected and subsequently purified in a second Pu cycle. Various experiments were performed regarding plutonium valency adjustment in the feed solutions. Recently, the influence of various additives in the feed and scrub solutions for the first column to improve fission-product decontamination was investigated. Future plans include studies of alternate extractants and other process variables. (auth)

37279 (A/CONF.28/P/767) EXPERIMENTS ON THE REPROCESSING OF URANIUM FISSION PRODUCT SOLUTIONS BY THE EXCLUSIVE USE OF ION EXCHANGERS. O. Bobleter (Osterreichische Hochschule, Vienna. Atominstitut). May 1964. 19p.

Inexpensive cation exchangers on wood basis were developed which demonstrated good separation properties for certain fission product elements, and it therefore seemed feasible to examine a complete reprocessing procedure using only ion exchangers. The maximum loading factor and elution velocities possible for uranium and the main group of fission products were determined in several column experiments. In the first exchange step, a pre-separation of uranium from the fission products (Cs^+, Sr^{2+}, Y^{3+}, etc.) was carried out using an anion exchanger (Dowex 1 × 8), A4.2 M aluminum nitrate solution gave good results as elution medium. Part of cerium-III remains adsorbed with the uranium on the exchanger. In this case, the maximum elution velocities are relatively low. In the second exchange step, the final separation of uranium from the fission products, which remain adsorbed with it on the anion exchanger, is carried out with a sulfonated cation exchanger on wood basis. The uranium–cerium-III separation can be successfully obtained with a diluted NH_4NO_3–HNO_3 solution, and high elution velocities are possible, although both elements have similar nitrate complex properties. In the third exchange step, the fission products are separated singly, also with a cation exchanger on wood basis. Good results were obtained by elution with nitric acid, the concentration of which was stepwise increased. Cs^+, Sr^{2+}, and Y^{3+}, which still contained $Al(NO_3)_3$ from the first exchange step, were separated by elution with 0.015, 0.14, and 0.47 N HNO_3. In this case also high elution velocities can be applied. The beta and gamma doses were calculated for the exchanger which is irradiated to the greatest extent. For this calculation it was assumed that the daily fuel consumption of a 100 Mw(t) nuclear reactor has to be reprocessed by means of ion exchangers. The result of the calculation indicates that the process can be easily conducted in such a manner that no significant radiation damage occurs to the exchanger material. (D.L.C.)

37280 (A/CONF.28/P/771) REPROCESSING OF NUCLEAR FUELS BY VOLATILIZATION. J. Schmets, G. Camozzo, A. Francesconi, P. Godrie, R. Heremans, G. Pierini, and P. Speeckaert (Centre d'Etude de l'Energie Nucleaire, Mol, Belgium). May 1964. 19p.

Different reprocessing cycles were studied for some ceramic fuels in the form of oxide or carbide, and for some uranium alloys. The oxides and the carbides are submitted to gas-solid reactions, which, in one way, pulverize the fuel and facilitate the formation of plutonium and uranium hexafluorides, and, in the other way, permit the spreading of the heat liberated during these transformations. The study of processing of alloys pertained to the following elements: U–Zr, U–Mo, U–Nb, and U–Al. Some chemical conditions of reaction and separation under the action of chlorinating agents were studied. For the uranium–aluminum alloy, the research has evolved towards a cycle of processing by chlorination and fluorination, where hydrochloric acid is called upon to volatilize the aluminum; the residual uranium trichloride can subsequently be transformed into hexafluoride. (auth)

37281 (A/CONF.28/P/772) THE USE OF INORGANIC ION EXCHANGERS IN ACID MEDIUM FOR THE RECOVERY OF Cs AND Sr FROM REPROCESSING SOLUTIONS. L. Baetsle, D. Van Deyck, D. Huys, and A. Guery (Centre d'Etude de l'Energia Nucleaire, Mol, Belgium). May 1964. 15p.

The search for new synthetic mineral ion exchangers exhibiting selective uptake of long-lived fission products has led to the elaboration of a separation scheme for cesium and strontium from reprocessing solutions. Zirconium phosphate, whose chemical, physical, and radiochemical properties are reported in connection with its structure, shows selective ion exchange properties for cesium in acid medium. The loading of cesium reaches a maximum of 0.2 me/g when a solution containing 0.5 g/l cesium and 0.5 N in acidity is fed to the zirconium phosphate in the H^+ form. That corresponds to a concentration factor of about 60. The results are presented for several types of reprocessing solutions, a.o., those reported by the Hanford, Windscale, and Marcoule plants, and those expected at the Eurochemic plant. A new family of synthetic ion exchangers was found by precipitating in acid medium Na_2MoO_4 or Na_2WO_4 solution with $H_4Fe(CN)_6$. The ferrocyanide molybdate ion exchanger has an extremely high affinity for cesium, which allows the separation from reprocessing waste solution of 2M HNO_3. A concentration factor of nearly 100 may be achieved leading to a maximum loading of 0.5 me/g at this high acidity. The difficulties encountered with the strontium separation in acid medium and in the presence of bulk ions are outlined; some promising results were obtained with clinoptilolite after dilution of the feed solution. An experi-

mental set-up built for the separation of strontium and cesium with mineral ion exchangers is reported with emphasis on its technology. (auth)

37282 (A/CONF.28/P/773) SOME DEVELOPMENT WORK DONE AT EUROCHEMIC. E. Detilleux, E. Lopez-Menchero, A. Redon, G. Rolandi, and R. Rometsch (European Company for the Chemical Processing of Irradiated Fuels, Mol, Belgium). May 1964. 17p.

The operation of pulsed extraction columns was investigated using a full-scale pilot plant. Air pulsation of the extraction columns and detection of the bottom interface by air bubbling, specifically, were considered. A process for final Pu purification was developed, involving extraction of the Pu by trilaurylamine (TLA) followed by precipitation, directly from the organic phase, of the Pu as an oxalate. The use of TLA or other tertiary amines to achieve, without any reducing agent, the separation of Pu from U was also considered, as well as the substitution of tertiary amines by quaternary ammonium salt, particularly for Pu purification. Chemical dissolution of graphite–carbide fuel elements was also investigated. (D.C.W.)

37283 (A/CONF.28/P/786) FUEL REPROCESSING PLANT AT TROMBAY. H. N. Sethna and N. Srinivasan (India. Atomic Energy Establishment, Trombay). May 1964. 20p.

A Fuel Reprocessing Plant based on the Purex process for aluminum-clad uranium metallic fuel elements is nearing completion at Trombay. The plant has provision for conversion of plutonium nitrate to any desired end product including plutonium metal. The hot equipment is housed in cells of hematite concrete walls (density 3.4 g/cc) with thickness varying from 900 to 1,500 mm. Chemical dejacketing of the 3,400 mm long fuel section and dissolution of uranium will be carried out in a 4,500 mm long horizontal dissolver. Pulsed columns are used for all steps of extraction and ion exchangers are used for the final purification and concentration of plutonium nitrate. All aqueous wastes generated in the process are subjected to multiple stages of evaporation till the liquid effluents released to the environments are to drinking water tolerances. The concentrated acidic and alkaline active wastes are stored in underground reinforced concrete tanks lined with stainless steel and mild steel respectively with a total capacity of about 7,000 cubic meters. (auth)

37284 (A/CONF.28/P/787) CHEMISTRY OF SEPARATION OF PLUTONIUM FROM IRRADIATED FUEL. A. S. Ghosh Mazumdar, M. N. Namboodiri, and H. D. Sharma, comps. (India. Atomic Energy Establishment, Trombay). May 1964. 15p.

The extraction of uranium, plutonium, and mixed fission products from simulated solutions of irradiated fuel by TBP in locally available kerosene as diluent was studied with a view to collecting data for the design of a spent fuel reprocessing plant. The distribution coefficients for different concentrations of TBP in kerosene were determined as a function of nitric acid concentration in the aqueous phase and of the degree of saturation of the solvent phase with uranium. The data are presented in graphical form along with the distribution coefficients for specific fission products like ruthenium and zirconium. The general trend of the results is the same as that of other published work, but differences in actual values of the distribution coefficients were observed. The final purification of plutonium by fixed-bed ion exchange was investigated with three different types of resins; viz., Deacidite FF, Amberlite IRA-400, and Dowex-I × 4. The variation of the distribution coefficients as a function of nitric acid concentration for both uranium(VI) and plutonium(IV) in the case of Deacidite FF and Amberlite IRA-400, and distribution coefficients of solvent extracted fission products with Dowex-I × 4 were obtained. Absorption, break-through, and elution behavior in a column maintained at 60°C and at room temperature, were examined. The mechanism of plutonium extraction in hexone, butex, and TBP was studied by determining the distribution coefficients of plutonium by varying the nitrate ion and the hydrogen ion concentrations. From the extraction equilibria, it appears that plutonium extracts as $Pu(NO_3)_4$ from the aqueous phase into hexone and butex; but in the organic phase at higher acidity, $Pu(NO_3)_4$ changes into $H_2Pu(NO_3)_6$. In TBP, plutonium nitrate is extracted as $Pu(NO_3)_4 \cdot 2TBP$. The values of stability constants for nitrate complexes of plutonium(IV) at various ionic strength, determined by solvent extraction using TBP, are presented. The stability constants for sulfate complexes were also determined. In the process plutonium is precipitated as its oxalate from the nitrate solution and calcined to its oxide for conversion to metal through its fluoride. The decomposition of oxalates were, therefore, studied using thermogravimetric and differential thermal analysis methods. The kinetic parameters, viz., heat of reaction, energy of activation, and order of reaction were calculated. (auth)

37285 (A/CONF.28/P/798) CHLORINATION DISTILLATION PROCESSING OF IRRADIATED URANIUM DIOXIDE AND URANIUM DICARBIDE. Takehiko Ishihara and Kenmei Hirano (Japan Atomic Energy Research Inst., Tokyo). May 1964. 15p.

Chlorination-distillation processing of irradiated pellets of uranium dioxide and of uranium dicarbide was studied, with the aim of utilizing the difference in vapor pressure between chlorides of uranium and those of fission products. The condensed uranium chlorides were recovered in the form of dioxide powder by oxidation-reduction cycling. (auth)

37286 (A/CONF.28/P/804) THE ROLE OF DILUENT IN EXTRACTION PROCESSES. S. Siekierski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). May 1964. 12p.

In many practical extraction processes suitable diluents were used to improve the physical properties of the organic phase employed. Although these diluents were selected from the solvents which are chemically inert, they are taking an active part in the extraction process, with influence upon the partition coefficients. Recent results are presented on the extraction of europium with dibutylphosphate (DBP). The thermodynamic activity of DBP in seventeen diluents was determined by measuring the partition of this extractant between the organic and aqueous phase. From the measured activity of the extracting agent, and from the europium partition data obtained for the same concentration of DBP, the magnitude of the interaction between the Eu-DBP complex and the diluent was calculated in the form of the thermodynamic activity coefficient. The interaction with the diluent was explained in part by the application of the concept with regard to the solubility parameter as a measure of the intermolecular interaction involved. The important role of interaction through hydrogen bonding of both the extractant and the complex with some diluents was revealed. (auth)

37287 (A/CONF.28/P/805) CHLORURATION–METHODE LA PLUS UNIVERSELLE DE CONCENTRATION DES MINÉRAIS D'URANIUM. (Chlorination at

Elevated Temperatures as a Versatile Uranium Ore Concentration Method). J. Zienkiewicz and T. Adamski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). May 1964. 16p.

The reaction of chlorine with uranium oxides and uranium minerals at different temperatures was investigated both in pure chlorine and in the reducing agents carbon and carbon monoxide. The mechanism and kinetics of the reactions were studied using the radioisotope ^{36}Cl as a tracer. The results show that the reaction of uranium dioxide with chlorine proceeds already at 225°C, uranyl chloride UO_2Cl_2 being formed, while chlorination of U_3O_8 as well as of UO_3 in presence of carbon proceeds at 300°C. A new, high-efficient apparatus to perform reactions of granular solids with gases at elevated temperatures was developed. Chlorination is considered to be a general, intense and versatile uranium ore processing method. (auth)

37288 (A/CONF.28/P/813) REVIEW OF THE STUDIES UNDERTAKEN IN THE UAR FOR EVENTUAL DISPOSAL OF LOW-ACTIVITY WASTES OF STRONTIUM, RUTHENIUM, CESIUM AND CERIUM INTO THE GROUND. M. A. El-Guebeily, M. Y. Farah, Aida E. Sinbel, M. S. El-Alfy, S. Shakour, H. Fouad, and G. El-Shobaky (United Arab Republic. Atomic Energy Establishment, Inshas, Egypt). May 1964. 12p.

Studies were made on the uptake of radioactive Sr, Cs, Ce, and Ru by the following Egyptian minerals: Mokattam and Sinai clays, Inshas sand, hematite, phosphorite, and zircons. The effects of particle size and pH on the uptake were studied. The efficiency of the minerals for decontamination was studied. (D.L.C.)

37289 (A/CONF.28/P/818) ELECTROCHEMICAL REDUCTION OF DILUTE NITRIC ACID. J. A. Epstein, I. Levin, and S. Raviv (Israel. Atomic Energy Commission, Tel-Aviv). May 1964. 20p.

Electrochemical reduction of nitric acid generally gives rise to undesirable products, such as ammonia, which interfere in subsequent processing of the waste. An attempt to find an electrochemical reduction process which would reduce nitric acid to gaseous products, and would not require the addition of foreign ions to the system, led to an investigation of the behavior of a graphite cathode in dilute (0.5–3N) nitric acid. Current-voltage curves, determined by a potentiostatic method, were measured at different acid concentrations, at different temperatures, and in the presence of urea and sodium nitrite. Electrochemical reduction of nitric acid takes place at positive potentials, the products of reduction being mainly gaseous oxides of nitrogen. The presence of carbon dioxide was also established among the products. The rate of the electrochemical reaction increases rapidly with increase in nitric acid concentration. There is evidence to show that the rate varies linearly with the concentration of nonionized nitric acid. At low acid concentrations, presence of nitrite increases the rate, while at high acid concentrations the addition of nitrite reduces the rate of the electrochemical reaction. The rate is also reduced in the presence of urea. The results indicate that one of the electrochemical reactions involved is the reduction of nitrous acid, which may be formed by the chemical reduction of the nitric acid by the graphite. (auth)

37290 (A/CONF.28/P/819) THE CHEMISTRY OF THE TRIVALENT ACTINIDES IN AQUEOUS SOLUTIONS AND THEIR RECOVERY. Y. Marcus, M. Givon, and M. Shiloh (Israel. Atomic Energy Commission, Tel-Aviv). May 1964. 19p.

A survey of the chemistry of the actinides shows how the properties of these complex systems contribute to the separation and recovery processes. The separation of actinides by elution with, e.g. alpha-hydroxyiso-butyric acid, from a cation exchanger, parallels the separation of the lanthanides. This process, indeed, was the only one capable of allowing the chemical identification of the heaviest actinides produced. The separation factors for neighboring elements are moderately high (1.6). These elements form complexes with up to four bidentate chelating ligands, and the anionic complexes formed are octocoordinated. The relative stability of the actinide and lanthanide complexes with these and related ligands may be correlated with properties such as the crystal ionic radii. Ligand field effects seem to be unimportant. A competitive process for mutual separation of the actinides is their extraction (e.g. in reversed phase chromatography) by an acidic phosphate ester, such as di-(2-ethylhexyl) phosphate. The separation factors (2.5) are even larger than in the above process. The complexes formed generally have three dimeric ester ligands, but complications occur in certain systems. The synergistic action of reagents such as TBP can enhance distribution coefficients and mutual separability. These actinide complexes have apparently coordination numbers of either six or eight. These processes cannot separate the actinides from the lanthanides present as fission products in process solutions. This can be accomplished by anion exchange or amine extraction from concentrated lithium chloride solutions at low acidity. This indicates that anionic complexes are formed, but spectrophotometric measurements on the lighter trivalent actinides, uranium to americium, show that only weak cationic complexes are active spectroscopically, as shown by the appearance of new uv peaks. Good anion exchange separation of americium and curium may be obtained with lithium nitrate rather than chloride. The behavior of the heavier actinides was also compared with the unusual even-odd atomic number effect shown by the lanthanides, and some information on the electronic state of these ions was obtained. Although some separation processes utilize the different oxidation states of the actinides to obtain efficient separation (e.g. of Am(VI) and Bk(IV)), the key to their recovery still lies in the knowledge of the behavior of the trivalent state in aqueous solutions. (auth)

37291 (A/CONF.28/P/821) THE SOLVENT EXTRACTION OF THORIUM FROM SULPHURIC ACID SOLUTIONS BY AMINES. M. A. Awwal (Pakistan. Atomic Energy [Centre], Lahore). May 1964. 20p.

Studies were made of the possibility of using amines extractants in irradiated fuel processing in the Th–^{233}U cycle. Secondary and tertiary amines, but not primary amines, were found to be promising. Two secondary amines (dioctylamine and di(tridecyl)amine) and two tertiary amines (trioctylamine and methyldidecylamine) were investigated for U and Th extraction from dilute H_2SO_4 solutions. The secondary amines were found to have the higher partition coefficients, but the tertiary amines were found to be more attractive for U–Th separation on account of the greater difference in the partition coefficients for Th and U. (D.L.C.)

37292 (A/CONF.28/P/823) ON THE BEHAVIOUR OF NITROSYLRUTHENIUM NITRATO COMPLEXES: IN TBP–HNO_3 SYSTEM. M. A. El-Guebeily, E. Hallaba, and Reda A. I. Azzam (United Arab Republic. Atomic Energy Establishment, Inshas, Egypt). May 1964. 11p.

The solvent extraction behavior of the nitrato complexes of nitrosylruthenium in TBP–HNO_3 system were studied. Both tracer (10^{-9}M) and macroscopic (10^{-3}M) concentrations of ruthenium were investigated. For tracer work, the complexes were prepared by Martin's method while for macroscopic work, Fletcher's procedure was used. A spectrophotometric study of both preparates at 10^{-3}M Ru concentration revealed that Fletcher's procedure gives directly the nitrato complexes, while Martin's method leads initially to RuO_4 in nitric acid which undergoes a series of successive reductions leading to the nitrato complexes after 17 hr. The extraction studies started with the system TBP–H_2O–HNO_3 without Ru and showed that the extractable species has the form TBP $(H_2O)_x$ HNO_3, where x was found to be equal to 1 and 4 depending on the method of evaluation, with more evidence in favor of 4. The equilibrium constant k for the formation of this product was calculated. The extraction behavior of nitrosylruthenium nitrato complexes at tracer and macroscopic concentrations was followed radiometrically. Measurements were carried out in equilibrium conditions. (auth)

37293 (A/CONF.28/P/836) LABORATORY AND PILOT PLANT TESTS ON THE PRODUCTION OF AMMONIUM URANOUS FLUORIDE IN REFINING OPERATIONS. R. E. Robinson, J. C. Geertsma, C. W. A. Muir, and G. Peratides (South Africa. Atomic Energy Board, Pretoria). May 1964. 16p.

Ammonium uranous fluoride (UF_4NH_4F) was precipitated from a solution containing uranyl nitrate, ammonium fluoride, and formic acid by the introduction of sulfur dioxide. At elevated temperatures the rate of precipitation of the UF_4NH_4F was constant and largely dependent on the initial acid concentration. The constant driving force during the reaction was attributed to the continuous regeneration of an active reducing agent and a reaction mechanism based on the generation in a formic acid-formaldehyde sulfoxylate system was proposed. The practical advantages of reducing reagent costs by re-using the regenerated reducing agent were demonstrated. Pilot plant tests showed that it was possible to produce a product of nuclear grade purity after having overcome severe corrosion problems. The present relatively high reagent cost of $0.84/kg U could be reduced to $0.31/kg U on a larger scale of operation. (auth)

37294 (A/CONF.28/P/839) NUEVAS ORIENTACIONES HIDROMETALURGICAS EN LA INDUSTRIA DEL URANIO. (New Hydrometallurgical Trends in the Uranium Industry). R. J. Cadirola, J. M. García Bourg, J. E. López Pardo, E. G. Macchiaverna, and C. A. Wiedmer (Argentina. Comisión Nacional de Energía Atómica, Buenos Aires). May 1964. 16p.

The uranium industry is at present going through a period in which reduction of costs must be regarded as one of the principal objectives to be pursued. Two methods of achieving this purpose are refinement of existing techniques, with a view to deriving maximum yield therefrom and replacement of the present intermediate products by others offering better economic and technical prospects. Tests involving application of both methods to the solid and liquid ion exchange technique, which is the one most commonly encountered in uranium technology, are described. For liquid ion exchangers, a comparative study was carried out with a view to maximum utilization of their specific properties. A summary is presented of the results of preliminary tests associated with any operation of this type, in order to facilitate the selection of the aminic solvent most suitable under the desired conditions. A comparative study of the behavior of certain amines with acid leachates is presented. The results are expressed in the form of equilibrium curves, effect of pH, phase separation resolving power, effect of the diluent, and so on. The results obtained show the undeniable advantages, under normal operating conditions, of certain tertiary amines over the others tested. The results of studies on the potentialities of uranium carbonate compounds, particularly uranyl tricarbonate of ammonium (UTC) as a substitute for yellow cake, are discussed. The results obtained with the delayed spontaneous crystallization technique and the direct precipitating elution are quoted. The prospects for preparing other materials are analyzed on the basis of UTC, and a summary analysis of their respective economic advantages is given. (C.E.S.)

37295 (BM-RI-6510) SEPARATION OF THE LANTHANIDE SERIES AND YTTRIUM USING PHOSPHONIC AND IMINODIACETIC ACID RESINS. J. O. Winget (Bureau of Mines. Reno Metallurgy Research Center, Nev.). Feb. 1964. 17p.

Phosphonic acid and iminodiacetic acid chelating resins were investigated to assess their potential as selective ion exchangers for separating lanthanide elements and yttrium. The affinity of phosphonic acid resin for lanthanides increases with increasing atomic number, and that of iminodiacetic acid resin for lanthanides increases with atomic number to a maximum for element 62 and then declines with atomic number throughout the remainder of the series. Elution sequences of the elements with mineral acid eluants corresponded favorably with equilibrium data, whereas the elution sequence obtained with chelating eluants was proportional to the relative values of the stability constants of the chelating agents with the lanthanides. Separation of lanthanide mixtures into groups of light and heavy elements with iminodiacetic acid resin appears feasible. (auth)

37296 (NP-14178) ADSORCION DE PRODUCTOS DE FISION SOBRE UNA BENTONITA DE MENDOZA. Informe No. 106. (Adsorption of Fission Products on Bentonites From Mendoza. Report No. 106). Leopoldo Jose Anghileri (Argentina. Comision Nacional de Energia Atomica, Buenos Aires). 1964. 10p.

The efficiency of bentonites in the decontamination of radioactive liquid wastes by the adsorption of fission products was investigated. The effects of the bentonite concentration, pH of the solution, contact time, grain size, and temperature on the adsorption were determined. Separations of the order of 98% were obtained. The adsorbed activity could be fixed in the bentonite by thermal treatment. Thermal treatment assures fixation even at acid pH. (J.S.R.)

37297 (ORNL-3559) TALSPEAK: A NEW METHOD OF SEPARATING AMERICIUM AND CURIUM FROM THE LANTHANIDES BY EXTRACTION FROM AN AQUEOUS SOLUTION OF AN AMINOPOLYACETIC ACID COMPLEX WITH A MONOACIDIC ORGANOPHOSPHATE OR PHOSPHONATE. Boyd Weaver and F. A. Kappelmann (Oak Ridge National Lab., Tenn.). Aug. 1964. Contract W-7405-eng-26. 64p.

Talspeak is an effective new method for the separation of americium and curium from the lanthanide elements which does not involve high concentrations of any salt or acid and is resistant to the effects of irradiation. This method is being developed as a possible alternative to the Tramex process currently in use to separate trivalent actinides from lanthanides by extracting with tertiary amine chlorides from concentrated lithium chloride solutions. Basically, the Talspeak process consists in highly prefer-

ential complexing of the trivalent actinides by an aminopolyacetic acid, so that the lanthanides and yttrium are much more strongly extracted by a monoacidic organophosphate or phosphonate. Simple carboxylic acids in the aqueous phase are helpful as buffers and solubilizers of the complexing agent. (In the absence of aminopolyacetic acids, simple carboxylic acids shift the relative extractabilities of the two groups of elements by dialkylphosphoric acids, but not enough to give an effective group separation.) Single-stage separation factors between neodymium, the least extractable lanthanide, and americium are about 50 in extractions with aromatic hydrocarbon solutions of di(2-ethylhexyl)phosphoric acid (HDEHP) from 1M solutions of any of several carboxylic acids containing only 0.05 molar pentasodium diethylenetriaminepentaacetate (Na_5DTPA), the most effective complexing agent tested, at pH 2.5 to 3.5. Other aminopolyacetic acids give smaller separation factors and/or are unsuitable because of solubility limitations. The presence of nitrate in the aqueous solution does not decrease the separation. After adjustment of the lanthanide-free aqueous solution to about pH 1.5, the actinides are readily extractable with a dilute solution of HDEHP in a suitable hydrocarbon diluent. The extracted elements may be stripped from the extractant by a dilute mineral acid. A tentative process flowsheet that should give complete separation of americium and curium from the lanthanides includes two cycles of extraction and one of stripping. It is based on single-stage experimental data from studies of variation of extractability as a function of identity and concentration of extractant, composition of diluent and modification of aqueous phases. Americium was completely separated from europium by this process in an application of the technique of extraction chromatography, thus confirming the group separation power of the method on a multistage basis. (auth)

37298 METHODS OF EXTRACTING URANIUM FROM ORES CONTAINING IT. Jean Le Bris, Pierre Mouret, and Paul Pottier (to Commissariat à l'Énergie Atomique). U. S. Patent 3,143,483. Aug. 4, 1964. Priority date June 20, 1955, France.

A method using Na_2CO_3 to recover U from ores is given which is economical and can be applied to ores of low U content. After the solution of uranyl carbonate complex is obtained, either by dissolution of the ore in acid and addition of Na_2CO_3 or by direct attack of the ore by a Na_2CO_3 solution, the solution is electrolyzed in the presence of a hydrogenation catalyst such as Ni. This produces nascent H which precipitates hydrated UO_2 from the solution. The catalyst and Na_2CO_3 remaining in the solution can then recycle. (D.L.C.)

37299 METHOD OF REPROCESSING NUCLEAR FUEL ELEMENTS. G. Strickland, R. Johnson, F. L. Horn, and C. B. Bartlett (to U. S. Atomic Energy Commission). U. S. Patent 3,145,078. Aug. 18, 1964.

A process is given for recovering uranium from clad nuclear fuel elements having a cladding of zirconium, stainless steel, carbides, or aluminum. The process comprises reacting the clad element with liquid NOF · X(HF) wherein X is an average number ranging from about 3 to about 12 while maintaining the temperature of the reactants between 80°F to about 100°F, recovering the liquid portion of the reaction products, evaporating this to dryness, and thereafter recovering the uranium from the solute produced by the evaporation. (AEC)

37300 PROCESS FOR SEPARATING SCANDIUM FROM MIXTURES CONTAINING SCANDIUM AND THORIUM VALUES. James D. Moore and Norman N. Schiff (to Vitro Corp. of America). U. S. Patent 3,146,063. Aug. 25, 1964. Filed Jan. 3, 1961.

A process for separating Sc from Th is given which is particularly useful in treating Sc–Th mixtures that result from processing of U ores. After the precipitation of Sc and Th fluorides from the stripped organic solvent by NH_4F · HF solution, the precipitates are converted into hydroxides and dissolved in HNO_3. An iodate is then added to precipitate Th, and after the iodate precipitate is removed, the Sc solution is subjected to hydroxide precipitation, acid dissolution, oxalate precipitation, and calcination to the oxide. (D.L.C.)

37301 DECONTAMINATION OF URANIUM. Robert L. Moore (to U. S. Atomic Energy Commission). U. S. Patent 3,146,064. Aug. 25, 1964.

A process is given for separating uranium values from plutonium(IV) and zirconium values by solvent extraction from an aqueous solution. The aqueous solution is made 2 to 7M in nitric acid and 0.01 to 0.1M in a fluorine-containing complexing agent for zirconium and plutonium(IV) (NaF, $(NH_4)_2SiF_6$, Na_2SiF_6, or K_2SiF_6). Uranium is then selectively extracted. Plutonium and zirconium can be decomplexed subsequently by the addition of aluminum nitrate, alkali metal nitrate, or alkaline earth metal nitrate for solvent extraction. (AEC)

37302 COMPOSITION FOR USE IN SOLVENT EXTRACTION PROCESS FOR THE RECOVERY OF URANIUM AND RARE EARTH METALS FROM AQUEOUS SOLUTIONS. Hamish Small (to Dow Chemical Co.). U. S. Patent 3,146,213. Aug. 25, 1964. Filed Mar. 4, 1963.

A composition of a gel-like solvent-containing alkenyl aromatic resin granules is described which possesses special advantages for the solvent extraction of U and rare earths. The granules consist of a copolymer of a monoalkenyl aromatic hydrocarbon (e.g., styrene) with a small amount (8 to 0.5%) of a divinyl aromatic hydrocarbon, and the granules contain on their surface hydrophile $-SO_3X$ groups (0.001 to 0.15 milliequivalent H^+/g). The granules are swollen with a trialkyl phosphate and a swelling solvent such as benzene or perchloroethylene. Examples are given of the preparation of such compositions and their use in separating U, Th, and Y. (D.L.C.)

ENGINEERING

General

37303 (A/CONF.28/P/834) STRENGTH PROBLEMS OF THE FLANGED JOINT. Josef Kuchta (Skoda Works, Pilsen, Czechoslovakia). May 1964. 18p.

One of the problems in the pressure vessels of nuclear power plants is the design of the removable joint of the cover. Three types of flanged joints were analyzed on a computer for a vessel of 6000 mm dia and 70 atm gage pressure. The joint type with free flanges proved optimal and the procedure of shape optimization for this type is described. Characteristic curves are given for the shape optimization. (D.L.C.)

37304 (APL-TDR-64-42) ALKALI-METAL-RESISTANT WIRE. E. S. Bober, R. E. Stapleton, and W. H. Snavely (Westinghouse Electric Corp. Aerospace Electrical Div., Lima, Ohio). Apr. 15, 1964. Contract AF33 (657)-10701. 149p. (AD-436294)

A ceramic coated conductor system was developed that was unaffected by 172 hours exposure to K (potassium) vapor at 850°C. This system was Metco 201 zirconia, plasma sprayed on nickel aluminide coated Nickel clad Silver AWG 8 (Sylvania) wire. This system, however, is not suitable for electrical operation at 850°C since the resistance of the zirconia coating drops to about 5 ohms at 600°C. Overcoating the zirconia with aluminum nitride by a vapor plating technique results in a resistance at 850°C in argon for the multicoat of 1.8×10^4 ohms. The aluminum nitride overcoated zirconia is unaffected by 172 hours exposure. Post exposure electrical resistance measurements of the coating were not completed. However, no significant decrease in resistance due to potassium vapor is anticipated. A number of high purity insulators were found to be resistant to potassium vapor at 850°C. These were alumina, magnesia, and strontium zirconate. A primary problem with plasma spray coatings of these materials is loss of adhesion in the potassium vapor even when a nickel aluminide undercoat is used. Pre- and post-potassium vapor (850°C) exposure resistance data on many materials was obtained; however, the electrical leakage resistance of the materials, while exposed to the metal vapors, could not be properly measured due to lack of a satisfactory electrical test capsule. Data obtained on lead in insulators of test capsules indicates a decrease in surface resistivity; however, the lowered resistance of these insulators (10^4 ohms) is still in a useful range. Statorette adherence tests show several insulated conductors will withstand vibration, shock, and acceleration conditions. Two insulated conductors were exposed to a nuclear environment of 10^{19} thermal neutrons and 10^8 rads gamma. The insulation resistance decreased in both insulation coatings. A statorette coil of nickel clad silver wire was partially insulated with nickel aluminide, zirconia, and alumina (98%) coating. The remaining portions of the conductor were coated with nickel aluminide and very high purity alumina (99.9%). The high purity alumina remained on the conductor after 172 hours, while the other insulating coating of zirconia (99.9%), alumina (98%) cracked and came off. (auth)

37305 (RTD-TDR-63-3041(Vol.IV)) EVALUATION OF TUNNEL LINERS IN GRANITE SHOT HARDHAT, OPERATION NOUGAT. STATIC TENSION TESTS OF LINING MATERIALS AND STATIC TEST OF 8 GAGE TUNNEL LINER PLATE. Final Report. J. L. Merritt (Illinois. Univ., Urbana). Feb. 1964. Contract AF29(601)-4993. 42p. (AD-433192)

Tests were made on samples of the steels used in the structural tunnel linings in the Hardhat experiment. Corrugated tunnel liner plate was also tested. A detailed study was made of the internal stresses and deflections induced by various load distributions in a ring of tunnel lining. (D.L.C.)

37306 (TID-20950) BUCKLING AND CREEP BUCKLING OF SPHERICAL SHELLS UNDER UNIFORM EXTERNAL PRESSURE. Summary Report. K. N. Tong (Syracuse Univ., N. Y. Research Inst.). July 1964. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26, Subcontract 913. 60p. (SURI-ME992-764S)

Results are presented of studies of the stability of spherical shells. These studies include a Jacob-series solution for thin spherical shells under non-uniform surface loading, and an iterative solution of axisymmetrical shells which are nearly spherical and subjected to a uniform external pressure. The status of knowledge of the elastic buckling of spherical shells is reviewed. Results are also presented of a study of the creep buckling of Cu and Al hemispheres. The effects of thickness-wise temperature gradients on the strength and stability of thin shells are considered. (D.L.C.)

37307 ELECTRIC PROPULSION FOR SPACECRAFT. Harold R. Kaufman (Lewis Research Center, Cleveland). New Scientist, 23: 263-5(June 30, 1964).

The principles and technology of contact-ionization and electron-bombardment ion engines are summarized, together with the status of neutralization and power sources for ion engines. The efficiency and lifetime of ion engines are also considered, as well as prospects for improvements therein. (D.C.W.)

Applications of Nuclear Explosions

37308 RESPONSES OF FOUR ROCK MEDIUMS TO CONTAINED NUCLEAR EXPLOSIONS. Charles R. Boardman, David D. Rabb, and Richard D. McArthur (Univ. of California, Livermore). J. Geophys. Res., 69: 3457-69 (Aug. 15, 1964).

Underground nuclear tests in tuff, alluvium, rock salt, and granite have yielded data essential to the evaluation of the effects of contained nuclear detonations. The data indicate that for these mediums the cavity radius is predictable within ±20 per cent without regard to the physical or chemical properties of the rock in the immediate shot environment. Properties of the chimney of broken rock resulting from collapse of the cavity, on the other hand, are found to be related to the physical properties of the rock and to preshot structural weaknesses within the rock. (auth)

Facilities and Equipment

Refer also to abstract 37563.

37309 (A/CONF.28/P/448) SHIPPING CASKS FOR THE BR2 AND HFR RESEARCH REACTORS. A. de Streel,

J. Van Mulders (Bureau d'Études Nucléaires, S. A., Brussels), T. de Schrynmakers de Dormael, G. Bonnet, C. Garric, and M. Trousson. May 1964. 15p.

The study of casks for the shipment of spent fuel elements from the BR2 and HFR research reactors is described. The HFR cask has already received USAEC approval and is on the point of being accepted by the competent Authority of the United Kingdom; the BR2 cask, designed according to the same principles, is now under examination. A summary is presented of the solutions selected to solve the various theoretical and technological problems to comply, under normal and accidental transport conditions, with the safety requirements prescribed by the new regulations in force, mainly the AEC 10 CFR Part 72 and AIEA regulations. The fabrication problems and the design features and layout selected to ensure the mechanical resistance, the handling, the anchorage, the structural integrity and the shielding are reviewed. Each cask contains an amount of fuel elements which exceeds the critical number. A solid stainless steel basket, which acts as neutron poison, is used to fulfill the subcriticality requirements. It allows easier decontamination, may be considered as indestructible in the accidental conditions contemplated, and acts as internal heat transfer medium in the absence of water coolant. The problem of residual heat removal, to maintain enough safety margin below the fuel element failure temperature, is investigated from a theoretical point of view. The internal primary coolant is either water or air, and fins are provided for external cooling. The cask resistance to fire is investigated from the following points of view: critical temperatures, mechanical resistance, and shielding effectiveness. A fire protection frame with insulating walls has been devised. This frame, which surrounds each cask, is also useful as shock absorbing and anchoring structure. (D.L.C.)

37310 (AERE-M-1397) A SUPERCONDUCTING TRANSFORMER AND CHARGING CIRCUIT FOR A HIGH FIELD MAGNET. D. A. Watt (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). July 1964. 12p.

The principle of operation of a superconducting transformer and charging circuit for building up very large superconducting circulating currents in a magnet winding operating under liquid helium is described, together with supporting experimental tests. (auth)

37311 (BNL-874(p.18)) PHOTOREACTOR DESIGN STUDIES. Frank B. Hill (Brookhaven National Lab., Upton, N. Y.).

The background, aims, and methods of photoreactor design are reviewed and work in progress is described. The term photoreactor refers to a vessel in which a chemical reaction initiated by radiation is carried out, usually on an industrial scale. Each problem under study is related to the same subject, namely, nonuniform initiation of complex chemical reactions, and especially the effect of mixing in the presence of nonuniform initiation. (P.C.H.)

37312 (HW-76460) THE HANFORD REMOTE MANIPULATOR SYSTEM. G. F. Howden (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 28, 1963. Contract AT(45-1)-1350. 17p.

The manipulator system can be used in high radiation levels to manipulate standard hand tools by simulation of the natural motion of the human body in using such tools. The system comprises a control console, a switch-gear cabinet, and a manipulator; the latter comprises a tractor-type vehicle, a mechanical arm, and a television camera. The system was used in recovering trapped irradiated fuel elements and in one criticality incident. Commerically available systems which are similar to the one described above are listed. (D.L.C.)

37313 (UCRL-13116) MODEL 1052—CLOUD SAMPLING SYSTEM. Descriptive Data 20072. D. W. Anderson (Beech Aircraft Corp., Wichita, Kan.). July 10, 1964. Contract W-7405-eng-48. 151p.

The cloud sampling system combines the major attributes of the AQM-37A Missile Target with straightforward sampling systems designed for efficient sampling and rapid retrieval and accessibility of samples. The system includes all ground handling equipment, checkout equipment, launchers, and associated launch equipment. The development program utilizes complete component, subsystem, and system testing; wind tunnel and computer studies; reliability, maintainability, and value engineering techniques to the fullest extent to insure a total system compatible with the operational requirements of nuclear testing. The development program as proposed insures that the final flight testing is simply a demonstration of the operational characteristics of the Model 1052 Cloud Sampling System. The AQM-37A Missile Target is an air-launched, liquid rocket-propelled, guided vehicle capable of flying at altitudes from 1,000 to 100,000 feet and at speeds from Mach 0.5 to over Mach 2. The propellants are hydyne and red fuming nitric acid. Modification required to the AQM-37A for the cloud sampling application is the repackaging of the stabilization and guidance components to free the entire nose section for the payload installation. The payload section, which replaces the nose portion of the AQM-37A, consists of a particulate sampler, a gaseous sampler, instrumentation, and recovery equipment. Particulate samples are collected on filter paper while the gaseous sample is collected in an expandable mylar container. A section of the nose shell is extended forward to form inlet and exhaust ducts for collection of the samples. The instrumentation and recovery requirements are met by components that have been used successfully on previous sampling systems. The RB-57F Launch Aircraft cloud sampling system provisions consist of modified standard LAU-24A launchers. The control consoles are simple panel units. (auth)

37314 ELECTRIC PROPULSION—1964. Ernst Stuhlinger (George C. Marshall Space Flight Center, Huntsville, Ala.). Astronaut. Aeronaut., 2: No. 8, 26-31(Aug. 1964).

The development of electrothermal, electrostatic, and electrodynamic thrustors is reviewed. Space testing, mission planning, and power supplies are also discussed. (C.E.S.)

37315 FAST-ACTING VALVE WHICH OPERATES AT TEMPERATURES UP TO 400°C. H. K. Forsen (Univ. of California, Berkeley). Rev. Sci. Instr., 35: 1362-3(Oct. 1964).

A fast-acting valve that is operated by magnetically driven acoustic rods is described. The valve incorporates a knife edge with a 65° included angle ground on the end of the actuating rod. The seat is OFHC copper in a soft condition. A Cu–Au O-ring makes up the other seal in the system and is held in compression by a threaded screw with internal hexagonal drive. (C.E.S.)

37316 REMOTE HANDLING OF RADIOACTIVE MATERIALS. K. R. Ferguson, W. B. Doe, and R. C. Goertz (Argonne National Lab., Ill.). p.463-538 of "Reactor Handbook. Second Edition, Revised and Enlarged. Vol. IV. Engineering." New York, Interscience Publishers, 1964.

General information on manipulator and viewing systems and shielded facilities used in research programs on reactor materials and chemical process development is presented. A bibliography of 478 references and an extensive selected reading list are included. (R.E.U.)

37317 DISASSEMBLY AND DECONTAMINATION APPARATUS ESPECIALLY FOR CALUTRONS. Albert Simon (to Commissariat â l'Énergie Atomique). U. S. Patent 3,143,119. Aug. 4, 1964. Priority date Nov. 29, 1961, France.

An apparatus is designed for the disassembly and decontamination of a radioactive vessel, such as a calutron vessel. The apparatus comprises a leakproof casing with glove holes and inspection windows and which is pivotally mounted on a horizontal shaft. The casing contains a stationary assembly of two jacks which are integral with two bell housings for sealing and washing the radioactive vessel. The operation of the apparatus is described. (D.L.C.)

37318 MACHINE FOR THE EXTRACTION OF NUCLEAR FUEL CARTRIDGES. René Guilloteau and Georges Petillat (to Commissariat â l'Énergie Atomique). U. S. Patent 3,143,231. Aug. 4, 1964. Priority date Apr. 15, 1960, France.

A machine is designed for the semi-automatic removal of irradiated fuel rods from a storage casing. The machine comprises in combination two assemblies, each with means for receiving and clamping a casing, a cutting head between the assemblies for subdividing the casing into two parts, and means for swinging the resulting half-casing so that their open ends are downward. The machine may be used under water, and the operations may be observed through portholes. (D.L.C.)

37319 MANIPULATING DEVICE. Alan Ainsworth (to United Kingdom Atomic Energy Authority). U. S. Patent 3,144,140. Aug. 11, 1964. Priority date Sept. 1, 1960, Great Britain.

A manipulator is designed which comprises an arm assembly supported on and slidable in a pivot and having operating and manipulating mechanisms at opposite ends. The arm assembly is jointed between the pivot and the manipulating mechanism, resulting in increased access and rotation freedom. (D.L.C.)

37320 PROCESS AND DEVICE FOR CRYOGENIC ABSORPTION PUMPING. Clyde E. Taylor, A. L. Hunt, and J. E. Omohundro (to U. S. Atomic Energy Commission). U. S. Patent 3,144,200. Aug. 11, 1964.

A cyclic cryogenic adsorption pumping system is designed for exhausting hydrogen to high vacuum at relatively high flow rates. In essence, a solidified gas or vapor film of material such as Ar, N_2, O_2, H_2O, N_2O, or CO_2 is deposited upon a thermally conductive surface maintained at approximately 11°K in a vacuum chamber maintained at approximately 10^{-9} mm Hg. The hydrogen to be pumped, upon opening the chamber thereto, is rapidly adsorbed upon the solidified substrate until same approaches saturation. Upon reclosing the chamber, and heating the surface to a temperature—say approximately 15°K—between the hydrogen triple point and the normal sublimation or boiling temperature of the substrate, the hydrogen is desorbed and, at its increased vapor pressure, is readily removed by conventional vacuum pumping. The adsorption-desorption cycle may be repetitively continued without replacing the solidified substrate. (AEC)

37321 FORCE LIMITING DEVICE FOR MOTOR CONTROL. John A. Pardini and Victor Hutter (to U. S. Atomic Energy Commission). U. S. Patent 3,145,333. Aug. 18, 1964.

A manipulator is designed that can transmit no more than a certain net force to an object to be handled to avoid damaging the object, in spite of a variable background force such as friction against which the manipulator operates. The manipulator includes parts that at the start of operation move relative to one another against a spring and so take a relative position dependent on the background force encountered in the particular operation. When the parts have taken this relative position, a time relay causes a control for a switch carried by one of the parts to become fixed to the other part so that a major disturbance of the said relative position of the manipulator parts causes the switch to be actuated for stopping the manipulator and avoiding damage to the object being handled. (AEC)

37322 APPARATUS FOR THE IRRADIATION OF MATERIALS WITH A PULSED STRIP BEAM OF ELECTRONS. Russell G. Schonberg, Craig S. Nunan, and Lawrence E. Brown (to Varian Associates). U. S. Patent 3,144,552. Aug. 11, 1964. Filed Aug. 24, 1960.

An apparatus is designed for the irradiation of thin layers of material by a pulsating strip beam without scanning. The material is passed between two irradiation heads. The operation of the apparatus is described in detail. (D.L.C.)

37323 SERVICING EQUIPMENT FOR NUCLEAR REACTORS. Robert Hugh Hall, Geoffrey Howard, and Cyril Charles Ovens (to United Kingdom Atomic Energy Authority). U. S. Patent 3,145,636. Aug. 25, 1964. Priority date Apr. 15, 1958. Great Britain.

A television viewing facility is designed for the remote examination of the internal structure of a reactor. The facility comprises a television camera mounted on an arm movable relative to a support member, and means for manipulating the support member, arm, and camera so that they can be aligned with an access hole and so that after insertion the camera can be aimed in different directions. The assembly and operation of the facility are described. (D.L.C.)

Heat Transfer and Fluid Flow

37324 (A/CONF.28/P/16) THERMAL AND IRRADIATION PERFORMANCE OF EXPERIMENTAL FUELS OPERATING IN STEAM–WATER MIXTURES. A. D. Lane and J. G. Collier (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.). May 1964. 15p.

Out-of-reactor heat-transfer experiments and an analytical model used to interpret the measurements show the importance of the thin water film over the heating surface in fog cooling. In fog cooling, liquid may reach the heating surface by turbulent diffusion of droplets in the steam or by flow of the surface film. The dry-out heat flux was studied for strings of instrumented fuel assemblies using connectors that would shed the water film and connectors that would not shed the water film. Crud deposition, hydriding, oxidizing, and mechanical changes under irradiation were studied. (R.E.U.)

37325 (A/CONF.28/P/50) AERODYNAMIC AND THERMAL STUDIES OF CANNING FOR GAS-COOLED FUEL ELEMENTS. Paul Gelin (France. Commissariat à l'Énergie Atomique) and Jean-Pierre Milliat. May 1964. 15p.

Studies on clusters are concerned chiefly with pressure

losses due to the assembly parts and with temperature variations around the cluster elements. The hot points of the can, the deformations of the rods, and the conditions of stability of these deformations may be determined satisfactorily. Studies on herring-bone cans are directed to the analysis of performances as a function of the geometric parameters and to the special aerodynamic and thermal features caused by the fins and by cartridge interruptions. These investigations have led to a very thorough knowledge of the cartridges chosen for the reactors EDF 2 and EDF 3, and now disclose hopeful prospects for future reactors, particularly those fitted with annular elements. Among the alternatives suitable for the inner surface of the annular element can, corrugations and longitudinal fins were tested over a wide range of Reynolds number. (auth)

37326 (A/CONF.28/P/93) HEAT TRANSFER BY ORGANIC LIQUIDS. F. Lanza (European Atomic Energy Community); R. Ricque, and Jean Villeneuve. May 1964. 15p.

Results are given for coolant-loop tests of the thermal exchange properties of various terphenyls, and of the influence on the heat transfer coefficient of fouling of the heated walls by OM2 terphenyl containing iron, chlorine, or high boiler residues as impurities. (R.E.U.)

37327 (A/CONF.28/P/95) DIPHASE VORTEX FLOW TECHNIQUE IN WATER REACTORS. C. Foure, C. Moussez, and D. Eidelman (Société Nationale d'Etude et de Construction de Moteurs d'Aviation. Division Atomiques, Suresnes, France). May 1964. 16p.

The advantages and methods of producing vortex flow in boiling reactors are discussed. Hydrodynamic and thermal tests were performed. (R.E.U.)

37328 (A/CONF.28/P/135) HEAT TRANSFER AND PRESSURE DROP PERFORMANCE OF HERRINGBONE AND HELICAL FIN FUEL ELEMENTS FOR URANIUM/MAGNOX REACTORS. C. Cunningham (English Electric Co., Ltd., Whetstone, Leics, England), B. E. Boyce, T. Davis, and B. N. Furber. May 1964. 15p.

The experimental determination of the heat transfer and pressure drop characteristics of polyzonal fuel elements is discussed. The performance data necessary for the selection of a suitable fuel element design is first considered. Test results are presented to illustrate the effects of changes in the salient element parameters (number or lead of fins) on heat transfer and pressure drop. The results are compared with predictions using previously published correlations. The refinements in test apparatus and a typical experiment design evolved to measure heat transfer under normal operating conditions are then described. Experiments to provide performance data for element assessment at low coolant flows are also reviewed, together with typical results. The results of tests to assess the effects of deformation and relative element orientation on heat transfer and pressure drop are presented. (auth)

37329 (A/CONF.28/P/136) HEAT TRANSFER PERFORMANCE OF THE POLYZONAL CAN FOR THE C.E.G.B. REACTORS. H. F. J. Hadrill (Gt. Brit. Central Electricity Generating Board, London), E. W. V. Acton, J. A. Hitchcock, and S. B. H. C. Neal. May 1964. 16p.

The heat transfer research into the polyzonal fuel element is described. Problems of interest to the reactor operator, and which make it necessary to obtain as accurate a correlation as is possible between laboratory data and the performance of the fuel element within the reactor, are outlined. The complex nature of both the fluid flow and the associated heat transfer processes around the polyzonal spiral surface which have previously eluded purely theoretical treatment have been investigated using a four-times-full-scale model. The basic understanding of these mechanisms is described. Suggestions are made for improving the heat transfer performance of the surface. Investigations into polyzonal heat transfer performance of the surface. Investigations into polyzonal heat transfer performance have shown that results are critically dependent on the circumferential variation in thickness of the heater tube wall, accumulated effects of manufacturing tolerances, and the presence of and errors in thermocouples. Other factors which have been investigated experimentally include the effects of flux peaking at the ends of the fuel elements and the differences between the end of a fuel element in a reactor and the electrically heated laboratory assembly. Measurements of the fuel element heat transfer parameters in a Berkeley Reactor are compared with laboratory results. The deterioration in performance which results from the creep deformation of fins, splitters, and braces is discussed and an indication of magnitude of the effects is given. The case of a failed fuel element containing an oxide mound on the surface of the uranium bar has been considered and the thermal performance evaluated from an experiment in which the geometry is simulated and a comparison is made with the results from an analog study. (auth)

37330 (A/CONF.28/P/327a) BURN-OUT HEAT FLUXES UNDER FORCED WATER FLOW. G. V. Alekseev, B. A. Zenkevitch, O. L. Peskov, N. D. Sergeev, and V. I. Subbotin (U.S.S.R.). May 1964. 18p.

Experimental data on boiling burnout under subcooled water and steam–water mixture flows in tubes are examined in relation to data on external, longitudinal flow around a single tube in a symmetric annular gap. The effects of various parameters on the burnout heat flux are considered, and empirical formulas for calculating the burnout heat flux are proposed. (D.C.W.)

37331 (A/CONF.28/P/326) SOME PROBLEMS OF HEAT TRANSFER IN LIQUID-COOLED REACTORS. V. S. Osmachkin (U.S.S.R.). May 1964. 22p.

The results of a theoretical study of specific features of heat exchange processes in the channels of non-compressible liquid-cooled reactors are presented. The possibilities of extending Prandtl's hypothesis about turbulent transfer coefficients to arbitrary flows are discussed. Approximate equations for rate and temperature pulsations in an arbitrary liquid flow are derived from formulas written as integral equations describing the transfer rate and temperature pulsation components. A mathematical analysis of mixing lengths introduced by Prandtl is presented. The problem of stabilized heat transfer and hydraulic resistance in the reactor channels is considered. The approximation of the turbulent viscosity coefficient is used to calculate stabilized heat transfer and hydraulic resistance in tubes and for streamline flows parallel to rod bundles. The results of calculations in a broad range of Reynolds and Prandtl numbers are in good agreement with the available experimental data. The use of the hydraulic diameter for heat transfer and hydraulic resistance calculations is shown to be invalid for the case of streamline flows parallel to bundles of rods. A new method is suggested for determining the equivalent diameter of rod bundles which makes it possible to apply the tube flow formulas for cal-

culating the heat transfer and hydraulic resistance coefficients in rod bundles. Calculations of heat transfer in circular tubes in the initial thermal region and in the sinesection thermal loop are presented. Relaxation length values for the temperature curve are given which help determine heat transfer for an arbitrary thermal loop. The problems of critical thermal loads during surface boiling of heat-transfer agents in the reactor channels and the mechanism responsible for a heat-exchange critical point are discussed. An analytical expression is developed for critical thermal loads for tube flows below boiling point. The equation derived agrees well with the experimental data. (auth)

37332 (A/CONF.28/P/329) THEORETICAL MODEL FOR TURBULENT TRANSFER IN THREE-DIMENSIONAL FLUID FLOW. N. I. Buleev (U.S.S.R.). May 1964. 20p.

A three-dimensional model of turbulent diffusivity is formulated, this model allows approximation of all nine components of tensor of turbulent stress and three components of turbulent heat flow involved in original equations of dynamics for the turbulent flows. The use of the developed model of turbulent diffusivity makes it possible to formulate mathematically and solve different hydrodynamic and heat transfer problems for liquid flows in ducts of arbitrary form. The model of turbulent diffusivity has been tested on calculated velocity and temperature fields in liquid flows in round tubes. Obtained values of velocity and temperature fields, resistance and number Nu factors give a good agreement with the available experimental results. Further the results of velocity and temperature fields calculation are given for turbulent flow of liquid in channels of other modes– in annulus, flat and square channels and rod lattices. Calculation results of velocity and temperature fields for above mentioned channels are compared with the available experimental results. (T.R.H.)

37333 (A/CONF.28/P/449) RADIOLYTICAL AND HEAT TRANSFER PROPERTIES OF SOME ORGANIC COOLANT-MODERATORS. I. Kiss and F. Szabo (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). May 1964. 20p.

The heat transfer properties of organics for reactor coolant-moderators are reported. The most important physico-chemical features of the eutectic 28% diphenyl in diphenyl-methane mixture (D-DM) were determined. The radiation effects on D-DM were studied. Experiments on diphenyl-diphenyl methane mixtures of various compositions did not reveal any appreciable energy transfer in the system. The radiolytic decomposition rate for alkyl diphenyls was found to increase with the length of the alkyl side chain. The experimental results show the D-DM mixture to be preferable to the polyphenyls owing to its low melting point and to be less sensitive to radiolysis than the mono-isopropyl-diphenyl. Some thermophysical parameters of D-DM in a wide range of temperatures as well as the convective heat transfer coefficient of the system were also determined. The convective and surface boiling transfer properties were studied on diphenyl, D-DM, and diphenyl-diphenyl oxide systems. The critical thermal load of the organic coolants under investigations was established at 260–400°C, 1.5–6 m/sec velocity, and for subcooling from 10–200°C. (auth)

37334 (A/CONF.28/P/524) THE INFLUENCE OF A DIRECT ELECTRIC FIELD ON THE HEAT TRANSFER TO COOLING CO_2 AT HIGHER THAN ATMOSPHERIC PRESSURES IN A NUCLEAR REACTOR. F. Berger and L. Derian (Ceskoslovenská Akademie Ved. Ustav Jaderného Výzkumu, Řež). May 1964. 19p.

The effect of an electric field on heat transfer from a cylindrical fuel element to CO_2 in a reactor was investigated. It was found that, depending on the parameters of the gas and the electric field, either an increase or a decrease in the heat transfer can be obtained at both polarities of the heat transfer surface. The increase was substantially larger than the decrease. The fuel element polarity that gave the largest increase of the heat transfer coefficient switched with increasing gas pressure. (D.C.W.)

37335 (A/CONF.28/P/569) ON THE TRANSIENT HEAT TRANSFER FROM HOLLOW CYLINDRICAL FUEL ELEMENTS IN BOILING SUPERHEATED CONDITIONS. A. Jannussis (Greece. Atomic Energy Commission. "Democritus" Nuclear Research Center, Athens). May 1964. 10p.

The heat transfer from an annular fuel element with metallic cladding on the interior and exterior and with cooling by passage of boiling water and superheated steam over the outer and inner surfaces, respectively, is calculated. (D.C.W.)

37336 (A/CONF.28/P/580) BOILING HEAT TRANSFER AND BURNOUT MECHANISM IN BOILING-WATER COOLED REACTOR. Kin-ichi Torikai, Masao Hori, Mamoru Akiyama, Tetsuo Kobori, and Hiromichi Adachi (Japan Atomic Energy Research Inst., Tokyo). May 1964. 16p.

Experimental and theoretical studies on heat transfer and fluid flow in boiling-water cooled reactors were pursued. The burnout phenomenon, which is one of the most important problems in heat transfer in boiling-water reactors, is discussed. Causes of burnout and burnout heat flux were studied in its relation to the high heat transfer rate of boiling water and the two-phase flow phenomenon. In studies in pool boiling, the growth rate of bubbles with low heat flux was investigated: experimental values agreed well with theory. For high heat flux, bubble behavior and change in time of temperature at the heating surface were observed, using a transparent electro-conductive glass heater. It was found that adherence of bubbles on the heating surface tended to increase rather than reduce the heat transfer rate. It is concluded therefore that burnout in pool boiling is caused not by the heating surface bieng covered by bubbles, but by the motion of combined and enlarged bubbles near this surface. This opened the possibility of predicting the burnout heat flux in pool boiling from an analysis of bubble motion, and predicted results were confirmed by experiment. Experiments on burnout were also conducted for coolant flow channels. In the range approaching burnout flux, pressure, vapor generating rate, and flow velocity were observed to present an oscillating phenomenon. From an analysis of these phenomena, it was established that the heat capacity of the heater and the flow characteristics of loops such as pump characteristics were also important factors affecting burnout. Flow oscillation was further investigated both experimentally and theoretically from the aspect of two-phase flow phenomenon. (auth)

37337 (A/CONF.28/P/589) HEAT TRANSFER AND HYDRAULIC STABILITY IN BOILING WATER REACTORS. M. Bogaardt (Eindhoven, Netherlands. Technische Hogeschool), C. L. Spigt, F. J. M. Dijkman, and N. Madsen. May 1964. 17p.

Fundamental work on heat removal by bubble formation and by increased heat diffusivity as a result of increased turbulence in boundary layers is described. A mathemati-

cal model was constructed of the heat transfer loop that is in operation under pressures up to 40 atm, at input powers up to 600 kw and inlet subcooling up to 40°C. The model is compared with the experimental results obtained from the loop. The on-set of flow instability is studied, and the nature of the instabilities is characterized in the region up to burn-out by means of analysis of power density curves. Again, pressure and inlet subcooling are varied. The dynamic characteristics of the loop are studied by means of transfer function analysis. The validity of the underlying linearization is discussed and the resulting transfer functions are compared with those obtained from noise analysis. Systematic burn-out studies of rod bundles are reported, including the analysis of flow instability preceding burn-out. (auth)

37338 (A/CONF.28/P/590) BURN-OUT IN SUBCOOLED FORCED CONVECTION BOILING OF POLYPHENYLS. D. A. van Meel (Netherlands. Nijverheidsorganisatie, TNO, The Hague). May 1964. 15p.

The effects of liquid velocity, degree of subcooling, and liquid composition on the critical heat flux of polyphenyls flowing upward through a round stainless steel tube heated by the Joule effect are discussed. A description of the test loop is given, and results are reported on terphenyl mixtures pressurized by direct contact with nitrogen. The heat flux at the moment at which a sharp increase of the resistance of the test tube is indicated by a burnout detector is interpreted as the real burnout heat flux. Some tests in which the test tube was damaged by effecting real burnout showed this to be permissible. After the measurements on terphenyls under nitrogen, the loop was modified in such a way that liquid and pressurizing medium are separated from each other in a diving bell by molten solder. This enables the study of the separated effects of low-boilers and gases. Results are presented on terphenyls containing no volatile components, and on the effects of increasing concentrations of nitrogen, benzene, and diphenyl. These results are interpreted on the basis of the degree of subcooling as derived from the experimentally determined vapor pressure curves. For this purpose a vapor pressure apparatus was developed permitting accurate measurements as a function of temperature and composition of mixtures of terphenyls and very volatile substances. This apparatus, which is connected permanently to the test loop, is characterized by the possibility of measuring under the conditions of a very small vapor space, as a consequence of which changes of the liquid composition are avoided. To obtain equilibrium conditions the liquid may be stirred during the measurement. (auth)

37339 (A/CONF.28/P/600) THE MECHANISM OF NUCLEATE BOILING. C. J. Rallis and H. H. Jawurek (University of Witwatersrand, Johannesburg). May 1964. 20p.

Before the full potential of boiling as a means of heat transfer can be realized it is necessary to have an understanding of its basic mechanism. This paper represents an attempt to approach the problem in a simple and direct manner. Only the simplest case of boiling, that is, nucleate boiling under saturated pool conditions, is dealt with. For many years latent heat transport has been considered to contribute negligibly to the total heat flux under all nucleate boiling conditions. Experimental results on nucleate pool boiling at saturation, reported herein, indicate that the ratio $(q/A)_{LH}/(q/A)_{Tot}$ increases steadily with increasing flux, tending to unity as $(q/A)_{Tot}$ tends toward burnout. Latent heat transport and convection together account for the total flux in saturated boiling. The bulk of this paper deals with the parameters entering into the formulation of $(q/A)_{LH}$. In the region of isolated bubbles the bubble source concentration, N, is identical with the nucleation site concentration, $\mathcal{N}$; at higher fluxes this is no longer the case, since vapor from several nuclei can coalesce to form only one bubble. The relation $(q/A)_{Tot} = \text{const.} \mathcal{N}^n$ where $n \simeq 0.5$ is confirmed for water boiling at atmospheric pressure and for organics at various low pressures. Using this relation and an equation characterizing nucleation from a cavity, and given a boiling curve, it is found possible to arrive at the size distribution of potentially active nucleation cavities; that is, a surface can be characterized with respect to nucleation. Data on both $\mathcal{N}$ and N, and hence coalescence, are presented. (T.R.H.)

37340 (A/CONF.28/P/607) HYDRODYNAMIC INSTABILITY AND DYNAMIC BURNOUT IN NATURAL CIRCULATION TWO-PHASE FLOW. AN EXPERIMENTAL AND THEORETICAL STUDY. K. M. Becker, S. Jahnberg, I. Haga, P. T. Hansson, and R. P. Mathisen (Aktiebolaget Atomenergi, Stockholm). May 1964. 19p.

A theoretical model for predicting the threshold of instability for two-phase flow in a natural circulation loop is presented. The model calculates the flow transient caused by a step disturbance of the heat input, and is based upon the conservation laws of mass, momentum and energy in one-dimensional form. Empirical correlations are used in the model for estimating the void fractions and the two-phase flow pressure drops. The equations are solved numerically in a finite difference approximation coded for a digital computer. Two versions of the model exist; one where the total pressure drop over the channel is prescribed and one where the total pressure drop is calculated from the downcomer data. An experimental study of the hydrodynamic instability and dynamic burnout in two-phase flow has been performed in a natural circulation loop in the pressure range from 10 to 70 atg. The test sections were round ducts of 20, 30, and 36 mm inner diameter and 4890 mm heated length. The experimental results showed that within the ranges tested, the stability of the flow increases with increasing pressure and increasing throttling before the test section, but decreases with increasing inlet sub-cooling and increasing throttling after the test section. Comparing the natural circulation burnout steam qualities with corresponding forced circulation data showed that the former data were low by a factor up to 2.5. However, by applying inlet throttling of the flow the burnout values approached and finally coincided with the forced circulation data. The present experimental results as well as data available from other sources have been compared with the stability thresholds obtained with the theoretical model. The comparisons included circular, annular and rod cluster geometries, and the agreement between the experimental and theoretical stability limits was very good, the deviations being generally less than 10 per cent. The application of the experimental and theoretical results on the assessment of boiling heavy water reactor design is discussed. It is shown qualitatively how hydrodynamic instability and burnout affect the optimization of the reactor performance. (auth)

37341 (A/CONF.28/P/698) HEAT-TRANSFER INTENSIFICATION BY USE OF THE LONGITUDINALLY VARIABLE PRESSURE GRADIENT. Z. Zaric (Institut za Nuklearne Nauke "Boris Kidric," Belgrade). May 1964. 17p.

A preliminary investigation of heat transfer in an annular diffuser has been undertaken which has shown a substantial increase in heat transfer rates in comparison with the flow with a zero pressure gradient. The experimental

investigation proceeded in a two-dimensional apparatus described. The test section consisted of a rectangular channel with two walls profiled in such a way as to form a succession of diffusing and converging sections with a half angle of 8°. The profiled walls were heated electrically and local wall temperatures measured along the channel by numerous thermocouples. The velocity and temperature profiles in the fluid were measured in four cross sections. The static pressure distribution along the test section was also measured. The experimental data show a considerable influence of the adverse pressure gradient on the heat transfer rate. The Stanton number based on the local flow area increases steadily along the diffuser up to more than twice in comparison with the flow without a pressure gradient. The intense turbulence created in the diffusing section influences substantially the heat transfer rate in the converging section too. The pressure loss coefficient which increases along the diffuser is greatly lowered in the converging section indicating a pressure energy recovery in this section. The results, obtained for a single geometry, show that the pressure gradient effect can be used successfully for heat transfer intensification with gas cooling. Other geometries are being tested in order to find an optimum combination of parameters which influence heat transfer and fluid flow. (T.R.H.)

37342 (A/CONF.28/P/699) BOILING FROM A LIQUID INTERFACE. M. Novakovic and M. Stefanovic (Institut za Nuklearne Nauke "Boris Kidric," Belgrade). May 1964. 16p.

The results are given of an investigation of boiling heat transfer from an ideally smooth surface, liquid to liquid interface. In this way, surface roughness is eliminated. An original apparatus is described which eliminates by-effects (e.g., boiling from solid surface). Horizontal mercury surface was used as the heating surface from which four liquids were boiled at atmospheric pressure. The liquid surface (interface) was kept very clean by a special experimental procedure. The boiling liquids were water, ethyl alcohol, benzol and n-pentane, all with boiling points from 35 to 100°C. The results of measurement of the boiling heat flux q, superheating of the heating liquid surface ΔT and the corresponding heat transfer coefficient α are presented. The superheating of the heating (liquid) surface was found to be higher than that of boiling from solid surfaces. Two boiling regions, visually similar, are clearly distinguished, convective boiling and nucleate boiling; conditions of transfer from one kind of boiling to the other are shown. The heat transfer coefficient as a function of the driving temperature difference (surface superheating) for both regions can be represented by $\alpha = C(\Delta T)^n$ where C is a constant dependent on physical parameters of boiling liquids and n a constant for all boiling liquids in the nucleate boiling region. The heat transfer results for all liquids are correlated to the physical properties of boiling liquids and represented in the dimensionless form Nu = f(Pr,Pe,Kp) where variables Nu, Pr, Pe, and Kp are dimensionless numbers based on bubble parameters. A preliminary study of nucleation mechanism by fast cine camera (6000 frames/sec) is reported. It is found that the bubble frequency increases with the increasing departing bubble diameter, which is opposite to the experimental results for boiling from solid surface. The possibilities of further detailed fast cine studies are discussed. In conclusion, possibilities of practical application of this phenomenon for high efficiency-high flux heat transfer and heat generating apparatuses, including power reactors, are discussed. (auth)

37343 (A/CONF.28/P/867) BASIC HEAT TRANSFER AND HYDRODYNAMICS STUDIES IN TWO-PHASE FLOW. M. Silvestri, N. Adorni, S. Bertoletti, I. Casagrande, L. Cravarolo, G. P. Gaspari, A. Hassid, C. Lombardi, E. Pedrocchi, and G. Peterlongo (Centro Informazioni Studi Esperienze, Milan). May 1964. 20p.

A general survey is presented of the experimental work performed at CISE in the field of heat transfer and hydrodynamics of two-phase flow in forced convection. The main results are indicated and some correlations of the experimental data are given. (auth)

37344 (AD-600574) VOID FRACTION MEASUREMENT. S. William Gouse, Jr. (Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering). Apr. 13, 1964. Contract Nonr-1841(73). 101p. (DSR-8734-2)

One hundred and thirty-nine references on various methods of void fraction and film thickness measurement were reviewed and indexed by subject. Since the radioactive particle attenuation techniques were the most frequently employed method for measuring void fraction, these techniques were studied in detail. The conclusion of this detailed study is that accurate measurements of void fraction are feasible when small diameter, low and mono-energetic photon beams are employed. Such requirements generally will exclude the use of radioisotope gamma ray sources but will not exclude radioisotope beta-ray sources. Much of the published void fraction data using radioactive isotope sources is in error by ± 10% or more. (auth)

37345 (AERE-R-4340) INTERPRETATION OF PRESSURE DROP DATA FROM AN ANNULAR CHANNEL. G. F. Hewitt (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). July 1964. 18p.

Equations are derived that can be used, provided the pressure drop is known, to determine the parameters of flow in an annulus having one smooth surface and one rough surface. The flow is divided into two regions, bounded by the plane of zero shear or maximum velocity, and Reynolds numbers, friction factors, etc., are defined for each region respectively. The von Karman velocity deficiency law is invoked to provide the key extra equation required in the solution. (auth)

37346 (GEAP-4631) A PROGRAM OF TWO-PHASE FLOW INVESTIGATION. Quarterly Report No. 5, April–June 1964. F. W. Staub and N. Zuber (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). July 17, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 105p. (EURAEC-1171)

Experiments at constant heat input and reduced pressures below 0.25 have been carried forward. Forty-five runs have been carried out, yielding the local pressure drop, heat transfer coefficients, void profiles and, through photography in the glass test section, the flow regimes. Computer programs have been developed to allow economic data reduction in conjunction with constant heat input experiments. The analysis takes into account both the effect of flow and concentration profile and the effect of the local relative velocity between the phases. Adiabatic data are compared with the theory. Local and average void fraction data from experiments with heat addition are used to demonstrate a proposed method of correlation. The method is reviewed, and only data taken at a reduced pressure of 0.22 are given. The overall performance of the loop and instrumentation sys-

tems has been most satisfactory, and few delays have been encountered. Only the wall temperature sensors required replacement. Some comments regarding overall stability observations are also discussed. (auth)

37347 (TID-20942) BOILING LIQUID METALS HEAT TRANSFER. Final Report. Max W. Carbon (Wisconsin. Univ., Madison). May 30, 1964. Contract AT(11-1)-1070. 19p.

A test apparatus was constructed for determining the heat flux at which film boiling occurs in liquid sodium. The heater element design is discussed; for preliminary designs, failure occurred at 770,000 to 870,000 Btu/hr-ft^2. An improved heater element gave 950,000 Btu/hr-ft^2, and it is expected that further improvement of the heater will give a heat flux for film boiling above 10^6 Btu/hr-ft^2. (D.L.C.)

37348 (TID-20983) HEAT TRANSFER IN COILED TUBES WITH TWO-PHASE FLOW. Research Report No. 4438. J. R. Carver, C. R. Kakarala, and J. S. Slotnik (Babcock and Wilcox Co. Research Center, Alliance, Ohio). July 31, 1964. Contract AT(11-1)-1280. 98p.

Studies were made to determine the effect of curvature of a tube on the departure of nucleate boiling (DNB), for the design of once-through sodium heated steam generators. Heat transfer tests were performed on two helical coil tubes, both with a nominal ID of 0.42 in., but each with a different radius of curvature which correspond to the smallest- and largest-radius coils in the Full-Size Sodium-Heated Steam Generator. The heat transfer tests were performed at a pressure of 2600 psia at mass flows from 280,000 to 1,400,000 lb/hr-sq ft and heat fluxes from 50,000 to 220,000 Btu/hr-sq ft. A steam–water mixture flowing in a coiled tube is acted upon by centrifugal force which tends to maintain nucleate boiling at the outside of the bend. DNB in coiled tubes occurs at different steam qualities for different positions around the circumference of the tube, whereas, for a straight vertical tube, DNB occurs around the complete circumference of the tube at one steam quality. Coiled tubes have higher average DNB steam qualities (or more per cent surface under nucleate boiling), than do straight vertical tubes. In most cases coiled tubes have higher DNB steam qualities than straight vertical tubes for all positions around the circumference of the tube. Where the transition is made from nucleate boiling to film boiling (DNB) the surface temperature fluctuations are much lower than those in a straight vertical tube. Surface temperatures under film boiling also are very low compared to those of a straight vertical tube. The small-radius (16 in.) coil maintains nucleate boiling to higher steam qualities than does the large-radius (65 in.) coil under comparable conditions. In the coiled tubes, an increase in mass velocity, in general, results in an increase in average DNB steam quality. This is in contrast to the inverse mass velocity effect present in straight vertical tubes under similar conditions. It is recommended that further tests should be conducted on coiled tubes at supercritical pressures to determine the supercritical-pressure inside-film heat transfer coefficient. (auth)

37349 DERIVATION OF THE TRACER BALANCE EQUATION FOR FLOW MEASUREMENTS. R. A. Evans and R. L. Ely, Jr. (Research Triangle Inst., Durham, N. C.). Intern. J. Appl. Radiation Isotopes, 15: 309-10(May 1964).

A mathematical derivation of the tracer balance equation for flow measurements, which more rigorously defines the conditions under which the equation continuity describes this situation, is presented. The equation is based upon the assumption that there are no sources or sinks of the tracer once it is introduced to the stream. (P.C.H.)

37350 OPTIMIZING A REACTOR COOLANT CHANNEL FOR MINIMUM BLOWER POWER. R. Naegelin (Therm-Atom, Winterthur, Switzerland). J. Nucl. Energy, Pts. A & B, 18: 377-85(July 1964).

Equations are given for the calculation of the optimum coolant cross-sectional area in the active part of a nuclear reactor and the optimum degree of surface extension of the fuel element walls, when the entrance temperature of the coolant and the admissible clad temperature are fixed. The problem is solved from a purely thermodynamic point of view. The results may be applied especially to reactors with a high flow resistance in the non-active part of the primary circuit. The introduction of some dimensionless numbers allows presentation in generally valid diagrams. (auth)

37351 FLUID FLOW. Charles F. Bonilla (Columbia Univ., New York). p.1-40 of "Reactor Handbook. Second Edition, Revised and Enlarged. Vol. IV. Engineering." New York, Interscience Publishers, 1964.

General considerations in fluid flow with regard to reactor engineering are discussed. Special characteristics of gas flow, nonboiling liquids, and two-phase fluids are discussed. A bibliography of 115 references is included. (R.E.U.)

37352 HEAT TRANSFER. Charles F. Bonilla (Columbia Univ., New York). p.41-106 of "Reactor Handbook. Second Edition, Revised and Enlarged. Vol. IV. Engineering." New York, Interscience Publishers, 1964.

Heat-transfer media and heat exchangers are considered with regard to reactor engineering. Media discussed include nonboiling water, liquid metals, fused salts, polyphenyls, gases, and boiling water. A bibliography of 195 references and a selected reading list are given. (R.E.U.)

Materials Testing

37353 (A/CONF.28/P/429) DEVELOPMENT OF NUCLEAR FUEL INSPECTION TECHNIQUES IN JAPAN. Noboru Takagi (Tokyo Univ.), Yoshitsugu Mishima, and Yoshiki Imai. May 1964. 17p.

In order to establish the inspection techniques for fuels, research and development works have been carried out among Japan Atomic Energy Research Institute (JAERI), Atomic Fuel Corporation (AFC) and private industries. Nondestructive testing techniques developed so far include: (1) application of ultrasonics for detecting internal defects in uranium billets, (2) radiographic measurement of aluminum cladding thickness, ultrasonic bonding test and determination of α contamination degree by ionization chamber device, which were developed especially for uranium metal fuels of JRR-3, and (3) eddy current test for sheath tubing of Mitsubishi Group's Reactor fuels. Works have also been going on for other inspection techniques related to the other types of fuels that are being considered. Standardization of fuel inspection techniques has also been considered and is discussed. (D.E.B.)

Vacuum Engineering

37354 ALL-GLASS SORPTION VACUUM TRAP. F. B. Haller (National Bureau of Standards, Boulder, Colo.). Rev. Sci. Instr., 35: 1356-7(Oct. 1964).

An all-glass sorption vacuum trap was designed to

overcome the problem of dust associated with adsorbents. The glass used as the trapping agent is a 96% silica, porous glass. It has about 28% void space by volume with average pore diameters of 40 Å and an internal surface area of 200 m^2/g. (C.E.S.)

37355 DEMOUNTABLE MULTIPLE STAGE ULTRA-HIGH VACUUM SYSTEM. Samuel E. Derby. U. S. Patent 3,143,594. Aug. 4, 1964. Filed July 13, 1960.

An ultrahigh vacuum system is designed which provides a vacuum of $\sim 10^{-9}$ mm Hg and can be demounted rapidly. The system comprises an outer bell jar that is exhausted to $\sim 10^{-5}$ mm Hg and an inner chamber that is exhausted to $\leq 10^{-9}$ mm Hg. Quartz-to-metal contact seals are used, and a degassing heater may or may not be provided within for baking the inner chamber without breaking the vacuum seal. (D.L.C.)

GEOLOGY AND MINERALOGY

General

Refer also to abstract 37082.

37356 (NAA-SR-Memo-9311) SIZE DISTRIBUTION AND STORAGE CHARACTERISTICS OF POTABLE SURFACE WATER SUPPLIES IN THE UNITED STATES. W. B. Sayer (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 20, 1964. Contract [AT(11-1)-Gen-8]. 24p.

Fresh water lakes in the world occupy approximately 300,000 square miles of land area and contain about 30,000 cubic miles of water. Large lakes (with volumes ≥5 cubic miles) comprise 77% of this water; the remainder being distributed into similar lakes, rivers and streams throughout the world. Little data exists on a world-wide basis concerning the size distribution and storage characteristics of the smaller lakes both natural and artificial which comprise municipal water supplies. Data on municipal water systems in the United States provide a good approximation for similar industrial and economic areas in the world but an overestimate in less developed areas. Large open reservoirs in the United States include 48% of the inland water area (exclusive of the Great Lakes). Reservoir sizes vary over a wide range. Closed type reservoirs such as tanks are economically feasible up to a capacity of 5×10^6 gallons each. Open type reservoirs generally have a much larger capacity. In the United States, 99% of the surface area of reservoirs used for drinking purposes is included by reservoirs with capacities in excess of 10^9 gallons and 80% above 3×10^{10} gallons. Storage characteristics of reservoirs are such that the average detention period for impounded water is 1.4 years or a water turnover rate in the reservoirs at 0.2% per day. The average water usage rate per day for municipalities within the United States is 150 gallons per capita per day. (auth)

37357 (NP-14227) SEISMIC-WAVE PROPAGATION FROM SALT-DOME ENVIRONMENTS. VESIAC STATE-OF-THE-ART REPORT. Changsheng Wu and G. C. Phillips (Michigan. Univ., Ann Arbor. Inst. of Science and Tech.). July 1964. Contract SD-78. 64p.

Buried explosions in salt domes generate seismic waves and fracture the medium in the region around the detonation. Results indicate that the mechanics and dynamics of fracturing are not quantitatively well known in detail. Seismic waves can be used to delineate the structural configuration of a salt dome. A continuous velocity log shows that the velocity in the salt is constant, while the velocity in the surrounding sediments varies with depth. It is suggested that the connection of salt domes with a single mother salt bed at depth may be tested by using the velocity contrast between salt and sediments. Significant decoupling effects, obtained by detonating a chemical explosive in an underground spherical cavity, are examined. It is concluded that proper equations of motions are already known, and theoretical computed waveforms are in very good agreement with experimental results. The decoupling factor is a function of frequency. Information obtained from the chemical explosion indicates that similar favorable results seem possible for nuclear explosions. (auth)

37358 ELEMENT DISTRIBUTION IN SOME ACID IGNEOUS ROCKS OF AFRICA. Joan M. Rooke (Univ. of Leeds, Eng.). Geochim. Cosmochim. Acta, 28: 1187-97 (July 1964).

Frequency distribution diagrams are presented for Ga, La, Mn, Pb, Rb, Sr, Y, and Zr in 130 acid igneous rocks from Africa, and major constituents are shown for 92 of the samples. Specimens from younger non-orogenic complexes and older basement plus older orogenic occurrences are present in approximately equal numbers; their respective contributions are compared and contrasted. Differences exist that suggest two distinct populations, and regional enrichments also affect the patterns. Calcium in a mixed group of rocks has a lognormal type distribution, but the older population within the group is near-normal and does not require logarithmic transformation. It is suggested that it would be unwise to adopt lognormality as a routine basis for comparison of data in a geochemical province investigation, since positively-skewed joint distributions have component populations that follow the normal law in some cases. (auth)

Natural Radioactivity and Fallout

37359 (A/CONF.28/P/384) CONTAMINATION OF OCEANS BY LONG-LIVED RADIONUCLIDES ACCORDING TO THE RESULTS. V. I. Baranov, V. M. Vdovenko, A. G. Kolesnikov, S. A. Patin, L. I. Gedeonov, L. M. Ivanova, N. I. Popov, L. M. Khitrov, and P. M. Chulkov (U.S.S.R.). May 1964. 19p.

A review is presented of data on the contents of strontium-90 in the waters of the Pacific, Atlantic, and Indian oceans and cesium-137 in the waters of the Atlantic ocean obtained by Soviet scientists in the period 1959–1963. A short review of the methods used, and the results of the analyses of over 250 samples of ocean water taken from the surface and deep horizons are given. Conclusions are given on the specific features of the process of radioactive contamination in each of the oceans. (D.L.C.)

37360 (A/CONF.28/P/385) SOME REGULARITIES OF DISTRIBUTION AND MIGRATION OF RADIOACTIVE ELEMENTS IN SOIL COVERING. V. I. Baranov, K. G. Kunasheva, N. G. Morozova, F. I. Pavlotskaya, and E. B. Tyuryukanova (U.S.S.R.). May 1964. 16p.

Results are presented of a study of the contents and distribution of natural radioelements (Th, Ra, and U) and of ^{90}Sr in different soil types in USSR. Differentiation of the radioelements with depth is discussed. The highest radioactivity level is found in soddy bog, alluvial clay-bearing soils of river bottomlands, while the minimum level is found in sandy soils, particularly in peat upland bogs. Differentiation of the radioelements with depth is discussed. (D.L.C.)

37361 (A/CONF.28/P/541) KRYPTON-85 IN THE ATMOSPHERE. D. Ehhalt (Heidelberg, Germany. Universität), K. O. Muennich, W. Roether, J. Schoelch, and W. Stich. May 1964. 8p.

The atmospheric krypton-85 content increased by an order of magnitude since 1955. Since spring 1961 monthly krypton-85 samples were collected in the Federal Republic of Germany. These samples are taken directly from the oxygen-argon-xenon-outlet of an air liquefier. They are purified by fractional distillation. The xenon which is not

removed from the samples is assayed by means of a mass-spectrometer, the krypton-85 activity is measured in a proportional counter. One finds a smooth increase in krypton-85 whose correlation with bomb testing is smaller than the experimental uncertainty. The krypton data presented confirms that krypton-85 is primarily due to other sources, most probably to nuclear fuel treatment. (auth)

37362 (A/CONF.28/P/558) SOME RESEARCHES ON THE ENVIRONMENTAL RADIOACTIVE CONTAMINATIONS IN ITALY. A. A. Cigna, M. M. Ferraris, F. G. Giorcelli, C. L. Papucci (Italy. Comitato Nazionale per l'Energia Nucleare. Centro di Studi Nucleari, Casaccia). May 1964. 14p.

The activity and composition of fallout collected at the Casaccia Centre for Nuclear Studies were determined during the period from 1961 through 1963. The following radionuclides were measured: ^{89}Sr, ^{90}Sr, ^{141}Ce, ^{144}Ce + ^{144}Pr, ^{103}Ru, ^{106}Ru + ^{106}Rh, ^{125}Sb, ^{137}Cs, ^{95}Zr + ^{95}Nb, ^{54}Mn, ^{140}Ba + ^{140}La. The correlation between meteorological features and fallout deposition was also studied, and some detonations were dated. Some measurements of sea-water activity due to ^{89}Sr, ^{90}Sr and ^{137}Cs were performed during the period 1960-1963. The sampling points were selected along the Italian coasts and samples were collected at least once or twice a year. Seasonal influences on ^{90}Sr contamination were investigated. Some samples of fishes as well as of other sea-organisms were also collected, and the contaminations of ^{89}Sr, ^{90}Sr, ^{95}Zr + ^{106}Ru + ^{106}Rh were determined therein. Apart from sea-organisms, the following items of the food chain were taken into consideration: soil, fresh water, hay, wheat, rice, vegetables, meat and milk. A search for ^{89}Sr, ^{90}Sr, ^{137}Cs and ^{131}I was conducted in the aforesaid materials. A correlation among the average values of radioactive contaminations in the different phases of the food chain was sought. (auth)

37363 (A/CONF.28/P/766) DETERMINATION OF INTENSITY OF RADIOACTIVE CONTAMINATION IN THE OCEAN BASED ON THE NEW DATA OF EXCHANGE PROCESS. V. I. Belyaev, A. G. Kolesnikov, and B. A. Nelepo (Akademiya Nauk Ukr. S.S.R.). May 1964. 10p.

Results are given of spreading rate calculations of radionuclides with various half lives (based on numerical solution by computers) of the complete equation of turbulent diffusion. This involves the really observed value of fallout on the surface from the beginning of the first tests. Turbulent diffusion coefficients and vertical components of the average current velocities were calculated. Solutions of the radionuclide concentration and the radioactivity at various depths in the Atlantic Ocean were analyzed. (auth)

37364 (A/CONF.28/P/769) STUDIES ON FISSION PRODUCTS IN THE ENVIRONMENT. Dan Beninson, Eric Vander Elst, and Esteban Ramos (Argentina. Comision Nacional de Energia Atomica, Buenos Aires). May 1964. 15p.

An evaluation is presented on the transfer and fate of fission products released into the environment, using information resulting from fallout studies and from laboratory and field experiments related to waste disposal. Data are presented from radiochemical and spectrometry studies on airborne activity, fallout rate, and cumulative deposition in Argentina for the past seven years. Relations between airborne activity, deposition, and rainfall are studied, as well as seasonal trends and other effects. Food chain contamination is examined with special emphasis given to pathways leading to man for strontium, cesium, and iodine radionuclides. Correlations of food levels with fallout rates and deposition are attempted. The soil-plant transfer step is studied using fallout data and information from experimental work relating to waste disposal. Some attention is paid to fresh-water food chains and to biological indicators, which may be useful in monitoring the vicinity of nuclear installations. The uptake of strontium-90 by humans is specially considered. Using data of diets and bones of infants and children of different age groups, strontium-to-calcium discrimination factors are worked out and discussed together with those obtained from stable strontium measurements. Data are appended on radionuclide levels in materials from the Antarctic. (auth)

37365 (AD-600447) THE INFLUENCE OF LOCAL WINDS ON FALLOUT. Report No. 1. Progress Report No. 1, July 1–December 31, 1963. Pieter J. Feteris, Edwin Kessler III, and Edward A. Newburg (Travelers Research Center, Inc., Hartford, Conn.). Contract DA-36-039-AMC-03283(E). 45p.

Model local wind circulations are discussed with regard to their influence on the deposition of airborne particles in a non-precipitation, non-diffusive atmosphere. Two-dimensional vertical circulations like the sea breeze along a straight coast, or like the circulations near mountain ranges, when steady-state, principally affect the time of establishment of a pattern and not its shape or the ultimate patterns of the total accumulations at the ground. When such circulations intensify or decay during the passage of fallout through them, both the duration and onset time of fallout at ground locations can be affected, with associated local changes of total accumulation. Three-dimensional local circulations affect the place of deposit of airborne particles and the time of their deposition. Circulations confined to the horizontal plane can affect the place of deposit and shape of a fallout pattern, but vertical air currents must occur to change the time of its establishment. Three-dimensional divergence accompanying vertical currents in the real compressible atmosphere significantly increases local concentrations in only those cases where updrafts are about equal to particle fall speeds; in such cases, the role of diffusion should be simultaneously considered. The influence of local circulations, in any case, is greatest with respect to the smallest (slowest falling) particles. (auth)

37366 (CEX-62-81(Final)) GROUND ROUGHNESS EFFECTS ON THE ENERGY AND ANGULAR DISTRIBUTION OF GAMMA RADIATION FROM FALLOUT. Civil Effects Study. C. M. Huddleston (Naval Civil Engineering Lab., Port Hueneme, Calif.); Z. G. Burson, R. M. Kinkaid, and Q. G. Klingler (Edgerton, Germeshausen and Grier, Inc., Las Vegas, Nev. and Reynolds Electrical and Engineering Co., Inc., Mercury, Nev.). Dec. 1963. Contract AT(29-2)-162. 73p.

The effect of ground roughness, or surface irregularities, on the radiation field above ground which was contaminated with fallout from the explosion in the atmosphere of a nuclear device (Smallboy Event) was investigated for three types of Nevada terrain: a flat dry-lake bed, a plowed field with a known and uniform degree of roughness, and typical wild desert. A modified 5-ton Navy 6 × 6 truck was used as a mobile laboratory. A collimator and a scintillation crystal with a 512-channel analyzer were used to measure gamma-ray spectra at various polar angles. Dose-vs-height measurements were also made up to a height of 40 ft. The gamma pulse-height distributions were unfolded to give energy spectra from which the angular distribution of radiation dose was calculated. Comparisons were made between theoretical predictions and these ex-

perimental determinations of directional dose. The project was undertaken to determine the importance of ground roughness as a factor in shielding against fallout radiation. (auth)

37367 (CONF-337-45) PROBLEMS ARISING IN THE STUDY OF RADIOACTIVE CONTAMINATION OF THE UPPER ATMOSPHERE. J. Z. Holland (Division of Biology and Medicine. Fallout Studies Branch, AEC). [1963]. 33p.

From International Conference on Radioactive Pollution of Gaseous Media, Saclay, France, Nov. 1963.

Problems encountered in studies of radioactive contamination of the stratosphere are reviewed. Meteorological data available on the stratosphere are reviewed and results of direct measurements of the concentration and distribution of radioactivity and their changes with time are discussed. Systems used for sample collection are evaluated. The need is stressed for evaluating the implications of contamination that may be injected into the atmospheric strata at about 100,000 to 300,000 ft by nuclear powered space vehicles and rockets propelled by nuclear fission reactors. It is estimated that space applications of radioisotopes or reactors could result in contamination of the stratosphere with quantities ranging from hundreds to millions of curies of radionuclides with half-lives of the order of a year or more. It is concluded that the probabilities and magnitudes of such releases must be carefully evaluated in advance and some estimate made of the resulting radiation doses to which people might ultimately be exposed. (C.H.)

37368 (HNS-1229-46) REDISTRIBUTION OF RADIOCONTAMINANTS BY SURFACE WATER FLOWS. PRELIMINARY STUDY. Robert L. Nevin (Bradberry (Carroll E.) & Associates, Los Altos, Calif.). June 22, 1964. For Hazleton-Nuclear Science Corp., Palo Alto, Calif. Contract AT(29-2)-1229. 36p.

A preliminary study was made of the potential for redistribution of radiocontaminants in a fallout area by surface water flows. The purposes of this study were to investigate the processes of transport and accumulation of radioactive material, and to evaluate the capability for accurate hazard appraisals with present knowledge. This study was concerned principally with the problems that may be encountered in areas where useful applications of nuclear energy may be proposed in the future rather than the situations at test sites selected for their isolation and favorable climates. It was concluded that the mechanism for significant redistribution and concomitant contamination of water supplies probably will exist in some areas, but that present knowledge of erosion, sedimentation, and the hydrochemical processes is insufficient for accurate predictions. It was concluded also that widely distributed deposits of contaminated particulate material could be accumulated by the processes of erosion and sedimentation and create long-term, continuing sources of contamination to water supplies. Further studies are recommended, including experimentation on the leaching, erosion, and sedimentation of dissolved and adsorbed radionuclides. (auth)

37369 (NP-14229) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 2, No. 7. (Canada. Dept. of National Health and Welfare. Radiation Protection Div., Ottawa). July 1964. 61p.

Data collected during June 1964 from various radiation protection programs in Canada are presented. Data are included on the radioactivity due to fallout in samples of air, precipitation, and surface waters collected at various locations, and the ^{137}Cs, ^{89}Sr, and ^{90}Sr content in milk samples. Film badges were examined for evidence of radiation exposures of workers in atomic energy, and field investigations were made of medical and industrial users of atomic energy. (C.H.)

37370 (NP-12548) THE RADIOACTIVITY IN AIR AND RAIN IN RELATION TO THE RADIOACTIVITY IN GRASS. H. H. Ph. Moeken and J. J. H. Alderhout (European Company for the Chemical Processing of Irradiated Fuels, Mol, Belgium). Apr. 12, 1961. 21p. (ETR-105)

Four categories of grass contamination by radioactive fallout are discussed. These include foliar contamination by dry deposition, foliar contamination by rain, stem-base absorption, and uptake from the soil. An analysis was made of certain literature data and some semi-quantitative relations were found between the radioactivity in air and rain and the radioactivity in grass. These relations, when applied to fallout problems described in the literature, give results which are in reasonable agreement with the known data. Evidence was found that dry deposition from the air is the major factor in grass contamination and that the total deposition on the earth's surface is mainly determined by the deposition in rain. (C.H.)

37371 (RT/PROT(64)-1) ON THE USE OF MOUNTAIN STATIONS OBSERVATION DATA FOR A STUDY OF THE MOVEMENTS AND SPREADING OF "IRRADIOACTIVE CLOUDS". G. Giudici, P. Mingrone (Italy. Comitato Nazionale per l'Energia Nucleare. Centro di Studi Nucleari, Casaccia), A. Gazzola, and S. Passantino (Italy. Servizio Meteorologico dell'Aeronautica Militare). Jan. 1964. 27p.

Observations of β-radioactivity made at mountain stations are used to study the passage and spreading of "radioactive clouds" over central Europe and, in particular, over Italy. The fission products caused by a series of Soviet nuclear explosions that took place from August 31, 1961, are used as tracers. The discussion, limited to the period that goes from September 1, 1961 to December 31, 1961, is based on β-radioactivity data recorded in a dense network of western and central Europe stations. A survey of the variations in radioactivity in space and time has been made, and data from mountain stations and low-level stations have been compared. It has therefore been possible to establish, with a good approximation, that a flow coming from the west with the jet stream appeared on September 13 over northern Italy, and a second one appeared in the lower layers on September 22 over the southern regions of Italy. (auth)

37372 (AEC-tr-6446) STUDY OF THE DISTRIBUTION OF THE ISOTOPES OF CERIUM, RUTHENIUM, ZIRCONIUM, AND NIOBIUM IN THE DECOMPOSITION OF SAMPLES OF RADIOACTIVE FALLOUT AND ATMOSPHERIC PRECIPITATION WITH MINERAL ACIDS. V. P. Shvedov, L. I. Gedeonov, M. I. Zhilkina, and G. V. Yakovleva. Translated from a Russian Report, State Committee on the Peaceful Uses of Atomic Energy, SSSR, Moscow, 1963. 43p.

The distribution of ^{141}Ce, ^{144}Ce, ^{103}Ru, ^{106}Ru, ^{95}Zn, and ^{95}Nb was determined in samples of atmospheric precipitation and fallout during the process of solution of the samples. A change in the content of macroimpurities and total fission products was demonstrated during the decomposition of samples with mineral acids. (C.H.)

37373 (JPRS-26002) RADIOACTIVE CONTAMINATION OF THE SEAS AND OCEANS. V. I. Baranov and L. M. Khitrov, eds. Translated from p.3-11; 92-169 of "Radioaktivnaya Zagryaznennost' Morei i Okeanov," Moscow, 1964. 113p. (TT-64-41273)

Artificial radioactivity (10^{-10} to 10^{-11} C/g of ashes) was detected in mass organisms of the Black Sea in 1958. The levels of radioactivity of marine organisms in 1959 comprised 10^{-10} to 5×10^{-10} Curie/g of ashes, and in 1960 decreased to 10^{-10}. Radioactive contamination of Black Sea organisms by radionuclides with a stable (more than 1.4 Mev) beta radiation is due primarily to cerium-144 and praseodymium-144. Plankton, Cystoseira, laurencia, and mussels were analyzed as representative species for the presence in sea water of fission products. In the muscles of fish (gray mullet, sea fox) no artificial radioactivity was noted within the limits of sensitivity of gas counters. (auth)

37374 MEASURING AND MONITORING FALLOUT RADIOACTIVITY. John H. Harley (Atomic Energy Commission, New York). Arch. Environ. Health, 8: 598-605 (Apr. 1964).

A general description of the measurements and equipment required for estimating hazard to man from radioactive fallout is given. Emphasis is placed on the peacetime situation, but a few points are made regarding nuclear warfare. In general, the high levels of radioactivity that would result from a nuclear war would allow hazard assessment with simple instruments, whereas the low levels existing in peacetime require more complex instrumentation and detailed measurements. (auth)

37375 TRITIUM CONTENT IN GLACIERS. Yu. A. Izrael, V. N. Kolesnikova, V. V. Romanov, and V. N. Soifer (All-Union Scientific Research Inst. of Nuclear Geophysics and Geochemistry, USSR). Dokl. Akad. Nauk SSSR, 156: 72-3(May-June 1964). (In Russian)

Ten samples of glacier ice were analyzed to determine the tritium content of glaciers and to establish a relation between its amount and the source of tritium in the earth. The samples were taken at about 5000 meters above sea level and represented layers formed in the years 1951 to 1961. The principal method by which tritium was formed in the earth in the period 1952 to 1958 is considered to be the tests of thermonuclear weapons. Graphs showing the accumulation of tritium in the earth and the concentration in the layers of the glacier for the period 1952 to 1961 are essentially parallel for the two values. An exception occurs in 1958, when the curve for tritium in the glacier, on the scales used, goes above the other. This and subsequent high values may be due to the slow rate of removal of tritium from the stratosphere. In the years preceding, the melted ice, with a high tritium concentration, may have penetrated to a deeper layer of ice. The measured value of tritium accumulated on the earth's surface for the period 1952 to 1961 is 2.4×10^{10} atoms of T per square centimeter, which is close to the calculated value. (TTT)

37376 MEASUREMENT OF RADIOACTIVE FALLOUT ON AIRBORNE PARTICLES. James Hardin, Seymour Gold, Bernd Kahn, and Conrad P. Straub (Robert A. Taft Sanitary Engineering Center, Cincinnati). Health Phys., 10: 563-75(Aug. 1964).

Radioactive fallout in air was measured at Cincinnati, Ohio, by analysis of filter samples collected with high-volume air samplers. Fallout from the USSR nuclear tests during the fall of 1961 was first detected on 15 September. Radioactivity levels were measured daily for the next 6 months. Radionuclides were identified and measured radiochemically and by gamma spectral analysis. The relative concentrations of the major fission products were comparable to computed values based on fission yield and radioactive decay. (auth)

37377 STUDIES OF RADIOACTIVITY OF GRANITOID INTRUSIONS BY MEANS OF AIRBORNE GAMMA SPECTROMETRY. L. I. Boltneva, V. N. Vasilenko, A. V. Dmitriev, V. A. Ionov, R. M. Kogan, Z. V. Kuznetsova, I. M. Nazarov, and I. V. Yagodovskii. Izv. Akad. Nauk SSSR, Ser. Geofiz., No. 6, 858-71(June 1964). (In Russian)

By means of gamma radiation measurements made with an airborne spectrometer 25 meters above granite intrusions, the uranium, thorium, and ^{40}K contents of the intrusions were determined. Comparison with laboratory data indicated a precision of 15 to 20%. It is concluded that data thus obtained may be used for locating radioactive ores. (tr-auth)

37378 RADIOACTIVITY AND RADIOGENIC HEAT IN SIERRA NEVADA PLUTONS. Harold A. Wollenberg and Alan R. Smith (Univ. of California, Berkeley). J. Geophys. Res., 69: 3471-8(Aug. 15, 1964). (UCRL-11210)

A radiometric traverse was made across granitic rocks in the Huntington Lake area of the Sierra Nevada, California. Field gamma counting rates were recorded, and samples were taken and subsequently evaluated in the laboratory for U, Th, and K content by gamma spectrographic analyses. These concentrations were converted to heat-generation values, using the factors given by Birch. Three principal plutons were sampled: a stock of pyroxene quartz diorite on the western border of the Sierra, hornblende-biotite granodiorite of the 'Dinkey Creek type' on the western slope of the range, and the Mount Givens granodiorite occupying the higher elevations east of Huntington Lake. The results indicate that the Mount Givens granodiorite averages nearly twice the U and Th content and, therefore, nearly twice the radiogenic heat production of Dinkey Creek granodiorite; the pyroxene quartz diorite is quite low in radioisotope content, and consequently in heat production, compared with the Mount Givens and Dinkey Creek plutons. The ratio of Th to U does not vary appreciably between the Mount Givens and Dinkey Creek plutons, averaging 3.24 in the Dinkey Creek and 3.06 in the Mount Givens. If the radioactivity of the Mount Givens granodiorite can be considered to be typical of the younger granitic rocks of the Sierra Nevada, and that of the Dinkey Creek granodiorite typical of the older plutonic rocks, a large central part of the batholith may have considerably higher radioactivity and radiogenic heat production than the older rocks on the western flank of the Sierra. (auth)

37379 RATE OF ACCUMULATION OF SNOW AT THE SOUTH POLE AS DETERMINED BY RADIOACTIVE MEASUREMENTS. E. Picciotto (Université Libre, Brussels). G. Crozaz, and W. De Breuck. Nature, 203: 393-4(July 25, 1964).

The rate of accumulation of snow at the South Pole as determined by stratigraphic observations and by measurements on the fission products and on ^{210}Pb are reported. The stratigraphic observations and fission product measurements were in good agreement. They indicate a mean annual accumulation of 6.5 ± 0.5 cm of water between 1955 and 1962. The ^{210}Pb activity was measured on a 2-m deep section covering the 1962-64 interval and on 60-cm thick specimens collected at intervals of about 4 m up to a depth of 26 m. The three completely independent methods lead to a mean value of the annual rate of accumulation between 6 and 7 cm of water at the South Pole. (P.C.H.)

37380 CONCENTRATIONS OF CAESIUM-137, RHODIUM-102 AND MANGANESE-54 IN SURFACE AIR. P. F.

Gustafson, S. E. Muniak, and S. S. Brar (Argonne National Lab., Ill.). Nature, 203: 470-2(Aug. 1, 1964).

Measurements on the content of ^{137}Cs, ^{102}Rh, and ^{54}Mn in surface air are discussed and values are reported and compared for 1952 through 1963. (P.C.H.)

37381 INFLUENCE OF METEOROLOGICAL CONDITIONS ON RADIOACTIVE CONCENTRATION IN GROUND AIR-LAYER AEROSOL. Teodor Kopcewicz. Przeglad Geofiz., 9: 3-24(1964). (In Polish)

After an introductory survey of present views on the transport mechanism of radioactive particulate matter from the stratosphere to the troposphere, the results of analytical studies based on systematic radioactive air pollution measurements by the stations of the Polish State Institute of Hydrology and Meteorology and data from four foreign stations are presented. Air pollutions were divided into transient and long-lasting ones. The meteorological reasons of the occurrence of transient and of long-lasting pollution are explained by air pollution caused by radioactive particulate matter passing in non-tropical cyclones from the stratosphere of the cold air mass to the troposphere of the warm mass through gaps in the tropopause. One illustrative example of long-lasting air pollution in Central Europe is described in detail. The question of rhythmicity in radioactive air pollution by stratospheric aerosol is sketched on the basis of measurement data from Legionowo and appropriate computations. A tentative explanation is given for the occurrence of annual variations (spring increase) of air pollution in middle latitudes in relation with the annual course of meteorologic conditions in the stratosphere and the troposphere. (auth)

37382 RADIOACTIVE FALLOUT IN SARGASSUM DRIFT ON TEXAS GULF COAST BEACHES. Cader A. Shelby (Univ. of Texas, Austin). Publ. Inst. Marine Sci., Univ. Texas, 9: 33-6(Dec. 1963).

In the spring and early summer of 1962 a large amount of seaweed (Sargassum) was washed up on the beaches of the northern Gulf of Mexico. The Sargassum heaps were weakly radioactive due to the presence of fallout. The radioactive elements from fallout (gamma emitters) included cerium, ruthenium, and zirconium-niobium. Beta radiation from the accumulated seaweed was roughly comparable to the total atmospheric precipitate during February over an area of approximately 800 to 1300 square miles in the Gulf of Mexico. (auth)

37383 RADIOLOGICAL HEALTH DATA [MONTHLY REPORT], VOLUME V, NUMBER 8. (Public Health Service, Washington, D. C.). Aug. 1964. 59p. $0.50(GPO).

Data are presented on the radioactivity from fallout in samples of air, precipitation, milk, foods, and surface waters collected during April 1964 at various locations throughout North and South America. Environmental levels of radioactivity during the calendar year 1963 are reported for Argonne National Laboratory and the Savannah River Plant, and from Oct. 1962 to March 1964 for the Nevada Test Site. Two low-yield underground nuclear tests at the Nevada Test Site during July 1964 were announced by the Atomic Energy Commission. Separate abstracts were prepared on five sections of this report. (C.H.)

For abstracts of individual papers see: 37384, 37385, 37386, 37387, and 37458.

37384 FISSION PRODUCT GAMMA ACTIVITY IN SURFACE AIR—80TH MERIDIAN AND U.S. LOCATIONS. William R. Collins, Jr. Radiol. Health Data, 5: No. 8, 360-2(Aug. 1964).

Results are reported from measurements of fission product γ activity in surface air at 14 sampling stations near the 80th Meridian (West) from Thule, Greenland, to Punta Arenas, Chile during March and April 1964. Comparative data are included from measurements made at Mauna Loa, Hawaii. (C.H.)

37385 RADIOACTIVITY IN WASHINGTON SURFACE WATER, JULY 1962–JUNE 1963. Robert R. Mooney and Peter W. Hildebrandt. Radiol. Health Data, 5: No. 8, 386-9(Aug. 1964).

Data are presented on the radioactivity in river water collected at 71 stations located on 65 rivers throughout the State of Washington between July 1962 and June 1963. Analytical methods used are described. Samples from the Columbia River are γ scanned for ^{51}Cr, ^{106}Ru, ^{95}Zr, and ^{65}Zn and samples from other rivers are analyzed for total β activity of dissolved and suspended fractions. (C.H.)

37386 TRENDS OF STRONTIUM-90 LEVELS IN SURFACE WATERS OF THE UNITED STATES, 1959–1963. Earl P. Floyd and Leo Weaver. Radiol. Health Data, 5: No. 8, 390-4(Aug. 1964).

Radioactivity levels in surface waters of the major river basins of the U.S. have been monitored since 1957 and ^{90}Sr levels have been determined since 1959. Data are presented on ^{90}Sr content in surface waters from Oct. 1962 through Dec. 1963. Samples collected between July and Sept. 1963 had appreciably higher levels of ^{90}Sr than previous quarters. The highest ^{90}Sr levels were in the north central area. Samples collected during the subsequent quarter were found to have lower levels of ^{90}Sr although relatively high ^{90}Sr levels continued in the north central area. (C.H.)

37387 RADIOLOGICAL SURVEY OF THE LOWER COLUMBIA RIVER IN OREGON, JANUARY 1962–JULY 1963. George L. Toombs and John G. Bailey. Radiol. Health Data, 5: No. 8, 395-400(Aug. 1964).

Results are reported from a radiological survey of the lower Columbia River in Oregon between Jan. 1962 and July 1963. The contribution of cooling waters from Hanford reactors and fallout to the radioactivity of the Columbia River are discussed. Data are included on the radioactivity of river water, sediments, and biological organisms. (C.H.)

37388 NEW RAPID METHOD FOR DETERMINING ATMOSPHERIC CONTAMINATION BY BETA RADIOACTIVE SUBSTANCES. A. Piatkowski (Warsaw Polytechnical Inst.). Symp. Tech. Zagadnien Ochrony Promieniowaniem, Warsaw, 252-60(1962). (In Polish)

The method presented permits the calculation of the value of the activity of the fission products of Ra, Th, and long-lived β-active materials within 2 hrs after sample collection. Previous methods required 3 days. The method is based on statistical counting theory applied to the decay curve of the activity of the material collected in the filters. The differential equations of the radiative decay permits an analysis of the decay curve, independent of the activity value of the collected fallout, the velocity of the flow-through, etc. From the analysis of the decay curve, the combination of the three algebraic equations is obtained from which the activity values can be obtained. (tr-auth)

37389 USE OF ACTIVATED CHARCOAL FOR DETERMINATION OF RADIOIODINE CONTENT IN AIR. G. M. Obaturov and V. D. Kuranov. Symp. Tech. Zagadnien Ochrony Promieniowaniem, Warsaw, 261-79(1962). (In Russian)

The application of activated charcoal to the determina-

tion of the concentration of radioiodine in air was investigated. The absorptive and desorptive capacity of the charcoal, the filter FPP-15, and tubes filled with various types of materials was determined as a function of the velocity of the air flow. A method for the measurement of iodine concentrations in the presence of radioactive gases was proposed. Under the most unfavorable conditions, 0.1 of the MPC of ^{131}I in the air could be determined with a background of 1 MPC in mixtures of gaseous fission products. (tr-auth)

37390 QUANTITATIVE DETERMINATION OF STRONTIUM-90 IN FOODSTUFFS (MANUFACTURED FOODS). W. Blume (Staatliche Zentrale für Strahlenschutz, Berlin). Symp. Tech. Zagadnien Ochrony Promieniowaniem, Warsaw, 280-92(1962). (In German)

Manufactured foods were analyzed during the second quarter of 1961 for ^{90}Sr and ^{89}Sr from fallout. The total values plotted (April 1961 to June 1962), calculated on an average daily intake, gave a relatively high value of 16.5 pc ^{90}Sr/day. The mean value of five quarters, expressed in Sr units, was calculated, on the other hand, as 8.3 pc ^{90}Sr/g Ca. This is lower than the value of 13 pc ^{90}Sr/g Ca estimated by E. Knoop for 1959 from the average West German food. Limited by the fluctuating Ca content of the samples, the disadvantages of the Sr–Ca separation can be clearly recognized. A method for Sr–Ca separation was worked out that depends on the different solubilities of $Sr(NO_3)_2$ and $Ca(NO_3)_2$ in water-free butyl alcohol. (tr-auth)

37391 SIZE DISTRIBUTIONS OF VARIOUS RADIOACTIVE AEROSOLS IN THE GROUND-LEVEL ATMOSPHERE. G. Schumann and E. Baust (Universität, Heidelberg). 7p. (CONF-337-35).

From International Conference on Radioactive Pollution of Gaseous Media, Saclay, France, Nov. 1963.

The size distributions of natural radon daughter and fission product aerosols were determined during 1963, using a Goetz aerosol spectrometer. The integral activity was obtained as a function of particle radius. The results were compared with previous determinations. The spectrum was shifted to smaller individual amounts of radioactivity with increasing time after nuclear test suspension and with increasing contribution from the stratospheric reservoir. (D.C.W.)

Site Survey and Selection

Refer also to abstracts 37791 and 38429.

37392 (A/CONF.28/P/87) RADIOPROTECTION PROBLEMS IN THE FACE OF THE DEVELOPMENT AND INDUSTRIAL USE OF NUCLEAR ENERGY. Francis Duhamel and André Menoux (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 13p.

The development of the industrial use of atomic energy has underlined the need to promote a rational and coherent doctrine relative to the safety of nuclear installations, with particular reference to nuclear sites. The chief aim in the safety field is to reduce or even eliminate irradiation or contamination risks to the workers and the population due to normal or accidental functioning of the installations. A complex set of safety methods is used, among which particular consideration is given to those which are to some extent independent of the type of installation: alarm and measurement systems and their setting in operation; technical and psychological training of individuals; and estimation of the capacity of a site to "absorb radioactive wastes without damage to the population." It is obvious, in effect, that the consequences of an accident are diminished by the improvement of monitoring, measurement, and alarm systems, by the raising of the technical level, and by training of personnel and the education of the population. This is particularly true near a nuclear installation, where a study of the danger is somewhat abstract in nature and the technological means of protection are many and complex. From investigations to test the suitability of sites, it is possible to determine the diffusion or reconcentration parameters in the various natural media; in this way the fate of radioactive effluents can be anticipated from the installation in which they have their source to man who may be exposed to them. The organization of radioactivity supervision on nuclear sites is very closely bound up with these studies. Among the many fields of investigation open, the following are emphasized: atmospheric diffusion experiments, the object of which is to determine the value of parameters established theoretically while at the same time taking account of complementary factors; hydrological, hydrogeological, and oceanographical studies, from which the fate of radioactive ions in the hydrosphere may be determined; and experiments and studies linked with the possibilities for underground storage of waste. All these studies cover a complementary field, that of radioprotection, which forms the necessary link between nuclear safety proper, which concerns the actual operation of nuclear installations and medical supervision, which directly concerns the health of the individual and the population. At the same time each one of the health physics disciplines possesses an independence which increases their efficiency on the safety level. (auth)

37393 (A/CONF.28/P/611) FACTORS OF ECONOMY, SAFETY AND HYGIENE IN LOCATING DIFFERENT TYPES OF LARGE THERMAL POWER STATIONS IN SWEDEN. S. O. W. Bergstroem (Aktiebolaget Atomenergi, Stockholm) and C.-E. Holmquist. May 1964. 16p.

The more important environmental and economy factors associated with the siting of power plants were considered. Qualitative analyses and quantitative estimates of the economic influence of the various factors were made. It was found that for sites fulfilling the other requirements, the choice between nuclear and fossil fueled plants can be greatly influenced by health criteria during normal operation. (D.C.W.)

37394 (A/CONF.28/P/840) INVESTIGATIONS ON SITE SELECTION FOR THE FIRST U.A.R. NUCLEAR POWER STATION. M. A. El-Guebeily, K. E. A. Effat, K. A. Mahmoud, M. F. El-Fouly, A. Ayoub, M. E. Aly, and M. Obeid (United Arab Republic. Atomic Energy Establishment, Inshas, Egypt). May 1964. 14p.

The main problems involved in the selection of a suitable site for the First U.A.R. Nuclear Power Station are illustrated, and the principal investigations carried out for the comparative evaluation of various sites are outlined. The anticipated power of the station is 100 to 200 Mw(e), and it will be integrated into the general electric 220 kv network. Electrical, radiation-safety, and constructional and operational requirements for the site were taken into consideration. (M.J.T.)

Techniques and Equipment

37395 (A/CONF.28/P/875) THE ROLE OF RADIOISOTOPE TECHNIQUES IN HYDROLOGY. B. R. Payne,

J. F. Cameron, A. E. Peckham, and L. L. Thatcher (International Atomic Energy Agency, Vienna). May 1964. 20p.

Radioisotope techniques are established as tools for investigating hydrological phenomena. The different uses are reviewed and examples cited of their application. Some of these techniques are at the stage where widespread application is justified, particularly in the evaluation of ground water resources. (auth)

37396 ON THE LIMIT OF SENSITIVITY AND THE ANALYTICAL ERROR. A. Hubaux and N. Smiriga-Snoeck (EURATOM CCR, Ispra, Italy). Geochim. Cosmochim. Acta, 28: 1199-1216(July 1964).

When a part of the results of a geochemical series falls below the limit of sensitivity of the analytical method, classical formulas for the estimation of the mean and the standard deviation are no longer valid. If however, it may be assumed that the population is homogeneous, and that the distribution law of the variable (or some transformation of it) may be fitted to a Gaussian distribution, different methods of estimation may be used. The one described is based on the method of maximum likelihood and is presented as a program written in Fortran. Examples have shown that the mean and the standard deviation may be estimated with it. Even when almost half of the results were under the sensitivity limit, the relative error was only a few per cent. The effect of the analytical error was tentatively taken into account with the help of a mathematical model. The same program also gives better estimates than the classical formulas when the results are grouped in very few classes, as is often the case with semi-quantitative analyses. (auth)

37397 APPLICATION OF RADIOACTIVE K-ISOTOPES TO THE DETERMINATION OF K-ADSORPTION AND K-RELEASE CHARACTERISTICS OF POTASSIUM-CONTAINING MATERIALS. F. A. M. de Haan, G. H. Bolt, and B. G. M. Pieters (Agricultural State Univ., Wageningen, Netherlands). Intern. J. Appl. Radiation Isotopes, 15: 221-9(Apr. 1964).

Because of the extreme half life times of the two radioactive K-isotopes available special planning is necessary for the application of those isotopes. Equations are derived relating the accuracy of the determination of the K-adsorption characteristics by means of ^{42}K and ^{40}K to experimental conditions chosen. Taking into account the high price of ^{40}K it is shown that reliable results at reasonable cost may be obtained using a special technique involving the direct determination of the specific activity of K present on the counting planchette. This technique was checked experimentally in short-term experiments substituting ^{42}K for ^{40}K. (auth)

Thorium and Uranium Minerals

37398 (A/CONF.28/P/24) CANADIAN RESOURCES OF URANIUM AND THORIUM. J. W. Griffith and S. M. Roscoe (Canada. Dept. of Mines and Technical Surveys). May 1964. 12p.

The Canadian resources of uranium and thorium are estimated with respect to present and potential reserves plus an additional allowance for geologically probable future discoveries. Results show that the Canadian mines have gradually reduced operating costs and that thorium is produced as a low-cost by-product of uranium production. (N.W.R.)

37399 (A/CONF.28/P/72) WHY EXPLORATION FOR URANIUM MUST GO ON. Jacques Mabile and Antoine Gangloff (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 15p.

At the 1958 Geneva conference, a report was given of the hopes placed in French uranium resources, and the work in hand on projects for mines and mills. Even though the French ground continued to confirm its promises, production has been limited because of the risk of massive overproduction. Moreover worldwide production surpluses remove any immediate worries about supplies. However, the French uranium potential, at the rate of exploitation which can be reasonably foreseen, seems to be limited, promising only a few decades of production. This situation is more serious still for Europe as a whole, at the very time when the rapid expansion of atomic energy is beginning. On a world-wide basis it may be anticipated that after the closing down of mines, an equilibrium between production and requirements will be reached in ten years, the increase in production being then easily achieved by the reopening of temporarily closed mines. However, by 1980 the requirements will exceed the maximum production capacity laid down in 1960-1961. Finally, toward the end of the century, there will be a discrepancy between the uranium reserves then necessary, and those which have been discovered in the world, at the cost of the considerable efforts made during the years 1948-1958. No time should be lost in an effort to discover new resources: either in countries not yet prospected or by the use of more sensitive methods. Failing this, the uranium market, badly shaken by present over-production, will suffer new crises unless the mining industry is well prepared in advance for a rapid exponential expansion after 1975-1980. (auth)

37400 (A/CONF.28/P/164) URANIUM AND THORIUM ORE RESERVES AND POTENTIAL. S. H. U. Bowie (Gt. Brit. Geological Survey, London). May 1964. 8p.

The confusion that exists concerning presently estimated reserves of uranium and thorium results largely from the loose usage of the term "reserves." The terms "reserves," "potential," and "resources" are defined and an indication given of the degree of confidence that can be placed in published or reserved data. An account is given of the history of the discovery of the major uranium fields and of the build-up of ore reserves during the period 1945-55. Reserve data are discussed and comments made on the potential of the known fields as well as of the possibility of finding additional provinces with comparable tonnages of ore. It is noted that no major ore deposit has been found since 1955 and that uranium reserves at the end of 1961 have been revised downwards by more than 30% as compared with figures for the end of 1958. This has resulted because ore reserves were estimated mainly from surface and borehole data, which gave an inadequate picture of changes occurring in depth. Of equal importance to reserves, from the long-term point of view, is the availability of ore. It is noted that if no major discoveries of uranium are made and current production maintained, by 1975 the reserves of the U.S.A. will be largely depleted and output in subsequent years can be expected mainly from the Republic of South Africa and from Canada. However, production from the former country is not likely to exceed 6000 to 7000 tons U_3O_8 a year, and the output from the latter may not bear a normal relationship to her total reserves, since approximately half the known uranium ore is in one property. Comments are made on the changes in prospecting technique that will be necessary to locate hidden deposits of uranium and thorium. Also, an indication is given of the basic research required to minimize the cost of exploration for additional ore when this be-

comes essential. Reserves of thorium are not known with the same degree of certainty as for uranium, but tentative figures indicate that they are of the same order as for uranium. (auth)

37401 (A/CONF.28/P/405) RECURSOS Y POSIBILIDADES URANIFERAS EN ARGENTINA. (Known and Estimated Uranium Reserves in Argentina). Carlos T. Friz, Felix Rodrigo, and Pedro N. Stipanicic (Argentina. Comisión Nacional de Energía Atómica, Buenos Aires). May 1964. 20p.

The uranium-bearing areas of the country contain three main types of deposit: sedimentary, vein-type, and pegmatitic. The first of these contains the largest concentrations; the vein-type deposits constitute only a small part of the whole, and those contained in pegmatites are, with a few exceptions, of no economic importance. The main features of the principal areas or deposits are briefly described; the volumes of the reserves measured so far and the estimated uranium content in each case are indicated, the volumes measured being classified according to the production costs of commercial-grade concentrates (greater or less than US $8/lb). A table is included showing the uranium minerals so far identified in Argentina and a tentative classification of the deposits by type of formation. (auth)

37402 (A/CONF.28/P/408) CONCENTRACION FISICA DE MENAS DE URANIO ARCILLOSO CALCAREAS DE BAJA LEY. (The Physical Concentration of Low-Grade Argillocalcareous Uranium Ores in Argentina). Marcos Mochulsky (Argentina. Comisión Nacional de Energía Atómica, Buenos Aires). May 1964. 16p.

The Don Rodolfo (Cosquín, Province of Córdoba) uranium ore deposit is characterized by large reserves of low content, thus necessitating preliminary concentration by physical methods to achieve economic recovery of the uranium. In this deposit the metal is present as carnotite and tyuyamunite, contained in argillocalcareous gangue, with contents ranging between 0.014 and 0.10% U_3O_8. Concentration assays were carried out. The results show that concentrates with a uranium content 3 to 4 times higher than that of the unsorted ore can be achieved, as well as recoveries of close to 70%. A supplementary operation consisting in processing the crushed and sorted ore with a shaking table leads to higher recovery of the uranium contained in the middlings. From a study of the results of enriching the ore by gravitational processes based on the use of hydraulic cyclone separators in conjunction with shaking tables, it is concluded that the higher the uranium content of the ore processed, the higher will be the content and recovery of the concentrate obtained. Since calcium carbonate enrichment of the concentrates occurs simultaneously with that of uranium, acid leaching is excluded as a method for the subsequent processing of the products obtained. (auth)

37403 (A/CONF.28/P/415) URANIUM DEPOSITS IN TERTIARY VOLCANITES OF NORTHEASTERN MACEDONIA. R. Pantic, D. Radusinovic, B. Sikosek, and M. Obrenovic (Institute of Nuclear Raw Materials, Belgrade). May 1964. 16p.

In the volcanic area of Kratovo and Zletovo, NE Macedonia, already known for the rich lead–zinc deposits, important uranium deposits have been discovered recently. This area is located in the border zone of the Dinaric orogene belt and the internides, i.e., in the axial part of the Alpine orogene of this area of Balcan Peninsula. The general geology is relatively simple and the main formations are paleozoic and lower paleozoic crystalline schists, tertiary volcanites and tertiary sediments. The volcanites cover an area of more than 1500 km^2 and are connected with a large, deep fault zone, located near the bordering area. This zone is in the north also marked by the similar volcanic complexes. The reserves in the explored part of the zone amount to about 300,000 tons of ore, with a mean uranium content of 0.15% of U_3O_8. (T.R.H.)

37404 (A/CONF.28/P/454) REACTORS GRADE URANIUM FROM UAR MONAZITE BY NEWER TECHNOLOGIES. M. Y. Farah (United Arab Republic. Atomic Energy Establishment, Inshas, Egypt). May 1964. 23p.

Two new approaches to uranium ore processing are reported. One involves chalk sintering–hydrochloric acid leaching and ion-exchange uranium fixation as chloride complex, followed by wet reduction to uranium dioxide or fluorination. This is a modification of the French alkali process. The other is extraction of reactor-grade uranium directly by trilaurylamine on the rare-earths barren monazite digests. This is a modification of the AMEX process. (T.R.H.)

37405 (A/CONF.28/P/478) PROSPECTING FOR AND DRESSING OF URANIUM ORE IN THE FEDERAL REPUBLIC OF GERMANY, PROGRESS IN METHODOLOGY AND NEW RESULTS. H. Closs (Germany. Bundesanstalt fur Bodenforschung, Hanover). May 1964. 20p.

The technical improvement of radiometers in Germany has currently followed the general trend of measuring techniques. Thus, for example, the digital recording and processing of data gathered in airborne measurements is well advanced. Geochemical uranium prospecting with mobile laboratories has been improved to such an extent that a small field crew can carry through 1,500 soil and water analyses per month. The modern methods of mineralogy including x-ray and structure analysis have rendered predictable from surface outcrops the mineral associations at greater depths. Absolute age determinations on ores and rocks by various methods, together with gamma spectroscopy have proved to be an important auxiliary means for judging the genesis of deposits. Particularly successful was the prospecting in the southern part of the Black Forest, where a pitchblende-bearing deposit was discovered in red iron-baryte-quartz veins. In large parts of the deposit concentrations of greater than 1% U were found. Owing to the extremely low present world market price of yellow cake, extensive research and technical development aimed at a lowering of production costs in the dressing of high-grade and low-grade ore. Relevant investigations using ores coming from 10 different deposits have been carried out in the dressing plant of Ellweiler. Only recently final tests were performed on a method which by a combination of ion exchange and liquid-liquid extractions permits recovery of nuclear pure solutions and uranates in the course of uranium-ore dressing. (auth)

37406 (A/CONF.28/P/483) NUCLEAR FUEL SUPPLY PROGRAM AND RESULTS IN BRAZIL. E. Tavora (Brazil. Comissao Nacional de Energia Nuclear). May 1964. 14p.

A program for the fast, approximate inventory of the nuclear ore resources in Brazil is outlined. The prospecting methods to be used are described. The structural elements of Brazil are discussed. The inventory should turn up the desired deposits within 2 or 3 years. (D.L.C.)

37407 (A/CONF.28/P/494) URANIUM IN SPAIN: PRESENT SITUATION AND FUTURE PROSPECTS. V. Membrillera, J. Josa, and E. Delgado (Spain. Junta de Energía Nuclear, Madrid). May 1964. 17p.

Spain initiated the prospecting for uranium and thorium about 1948 and, since that time, a large portion of the surface of the country has been prospected and studied. The results obtained to date have permitted the establishment of known uranium reserves of more than 6,000 metric tons of contained U_3O_8, recoverable at present market prices. These reserves increase considerably at higher levels of recovery costs. In the case of thorium the results to date were not very satisfactory, having been limited to small quantities. A description of the work completed to date and the results obtained in the various regions studied. The methods of prospecting and investigation followed are presented in detail, and some economic data related to the area explored and the reserves discovered are given. (auth)

37408 (A/CONF.28/P/501) PROSPECTING AND MINING OF NUCLEAR RAW MATERIALS IN PORTUGAL. Rogerio Cavaca (Portugal. Junta de Energia Nuclear, Lisbon). May 1964. 19p.

A uraniferous deposit was first discovered in metropolitan Portugal in 1909. This was followed by intensive prospecting and mining. A program of systematic radiometric prospecting was started in 1955 covering a favorable geological facies, namely all hercynic granitic massifs, all adjacent pre-ordovician schist complexes, and the continental formations belonging to the Autunian and the Miocene-Pliocene. Numerous occurrences and uraniferous deposits of various metallogenic types were identified. On the basis of present knowledge a preliminary estimate of reserves in metropolitan Portugal may be placed at 6,000 tons of U_3O_8, in ores of an average grade of 0.20%. Air-borne radiometric and magnetic surveying was carried out in Mozambique during 1961 and 1962, covering four areas selected according to their geological and structural characteristics. The well-known Tete deposits contain refractory mineralization (davidite and samarskite). The pegmatitic areas in the Zambézia district were surveyed in 1963, with a view to coordinating all geological, metallogenic, and economic data concerning the important deposits that were discovered since 1940. Beryl and niobium–tantalites are the predominant minerals. Estimates of the order of magnitude of the reserves are being prepared. (auth)

37409 (A/CONF.28/P/504) PORTUGUESE REQUIREMENTS AND SUPPLY CAPABILITIES REGARDING NUCLEAR FUELS. J. Rocha Cabral (Portugal. Companhia Portuguesa de Industrias Nucleares, Lisbon), and F. Marques Videira. May 1964. 11p.

The existence of considerable uranium reserves and of a uranium mining industry in Portugal, the predicted growth of electric power consumption through the year 2000, and the possible share of nuclear energy in meeting the increased power requirements are considered. An examination of fuel consumption both in qualitative and in quantitative terms according to various types of reactors, leads to the determination of uranium requirements for each one of such reactor types and for each one of some nuclear power programs postulated. The size of the uranium mining industry and some of the factors on which it depends are studied in confrontation with uranium reserves and with uranium requirements. The interest in and the possibilities of installing fuel element fabricating facilities, as well as related questions of general policy are also discussed. An analysis is made of the various possibilities of developing the utilization of uranium resources, and of the respective implications in the field of international cooperation. (auth)

37410 (A/CONF.28/P/521) A NEW TECHNIQUE FOR UPGRADING AUSTRALIAN THORIUM RESOURCES. A. W. Wylie and E. S. Pilkington (Australia. Commonwealth Scientific and Industrial Research Organization. Div. of Mineral Chemistry, Melbourne). May 1964. 14p.

A simplified "acid" process for extraction of Th from monazite is proposed in which a thorium concentrate is produced in a small number of stages with minimum quantities of inexpensive reagents. The yield of thorium exceeds 95 per cent. The concentrate contains approximately equal weights of rare earths as carbonates or hydroxides. After its solution in nitric acid, a suitable nitrate feed solution is provided for the tributyl phosphate solvent extraction process needed for refining thorium to nuclear grade. Principal features of the process are (1) the quantitative co-precipitation of thorium with rare earths by means of recycled sodium sulfate solution; (2) conversion of the double sulfate precipitate to double carbonates by treatment with sodium carbonate solution; and (3) selective leaching of the mixed carbonates with sulfuric or other acid to separate thorium from rare earths. The phosphate content of the residual thorium concentrate can be lowered, if required, by treating it with concentrated sodium hydroxide. Rare earth salts are valuable by-products and it is pointed out that the choice at any location between this process and the most competitive "alkali" process may largely be determined by the comparative profitability of by-product sales and the marked price differential which favors the use of sulfuric acid in Australia. (auth)

37411 (A/CONF.28/P/752) A REVIEW OF URANIUM AND THORIUM DEPOSITS IN INDIA. K. L. Bhola, K. K. Dar, Y. N. Rama Rao, C. Suri Sastry, and N. R. Mehta (India. Dept. of Atomic Energy, New Delhi). May 1964. 20p.

Almost all of the U deposits are in the Pre-Cambrian rocks in different parts of the country, with the most important deposits being located in the Singhbhum Thrust Belt in Bihar. Thorium deposits are widely scattered, and the monazite deposits are the largest in the world. Indian reserves of U_3O_8 and ThO_2 are estimated at about 30,000 and 500,000 tons, respectively. (D.L.C.)

37412 (A/CONF.28/P/768) APLICACION DE LA LIXIVIACION EN PILAS (HEAP LEACHING) EN EL TRATAMIENTO DE MINERALES ARGENTINOS. (Application of Heap-Leaching to the Processing of Argentine Ores). Aldo M. Cecchetto, Rafael C. Coppa, R. Del Boca, A. Licha, and Pedro N. Stipanicic (Argentina. Comision Nacional de Energia Atomica, Buenos Aires). May 1964. 16p.

The scattered distribution in Argentina of numerous uranium ore bodies possessing special characteristics has made it necessary to study the possibility of applying heap-leaching as an economic method of ore-processing. The need to attempt processing with unconventional methods arises from the presence of various favorable factors, such as: deposits of reasonable size but low-grade ores; many ore bodies of medium, normal or even high grade, but so small in size that it would not be worth while setting up conventional concentrating plants, added to the considerable freight costs resulting from the distance to be covered to reach them; and the existence of deposits from which normal grade ores can be obtained by selective working methods which, however, leave behind appreciable quantities of uranium of marginal or low grade, so that the deposits are not fully exploited. Results are included of heap-leaching trials with various Argentine uranium and copper–uranium ores, on both laboratory and semi-pilot-plant scale, more particular attention being devoted to the results for one typical ore, that from the "Don Otto" de-

posit (Salta Province). The method adopted is described. (auth)

37413 (A/CONF.28/P/838) TECNICAS DE PROSPECCION AEREA RADIMETRICA Y EMANOMETRICA TERRESTRE APLICADAS EN LA REPUBLICA ARGENTINA. (Radiometric Aerial and Emanometric Ground Prospecting Methods in Argentina). Carlos T. Friz, Jorge L. Gamba, Raimundo J. A. Jemma, Kirilo Marinkeff, and Carlos G. M. Martinez [Argentina. Comisión Nacional de Energía Atómica, Buenos Aires]. May 1964. 12p.

Sporadic aerial prospecting for radioactive ore deposits began in Argentina in the middle of 1958. Since 1960 the method has been applied systematically and has come to be used almost exclusively for the surveying of extensive uranium-bearing areas. Up to the present 75,000 km^2 have been prospected, in various regions, and 550 radioactive anomalies have been discovered, 250 of which have been selected for surface examination. Fifty of these have already been investigated and found to contain uranium contents of varying amounts and, in many cases, of economic value. A description is given of the features of the instruments and the improvements made to them, and the methods used in the field operations, for interpretation and correction of records, and for preparation of the final data. Mention is also made of a radiometric aerial prospecting trial over oil-bearing areas, covering 5000 km^2, in three separate regions of the country (Salta, Neuquén, Santa Cruz), and of the modifications made to the method for this purpose, aimed at eliminating, by means of geological interpretation supported by geochemical analysis, the errors due to the recording of radiation from thorium and potassium. Along with the application of the radiometric aerial prospecting technique, there has recently been a revival of the use of electrometers for the detailed prospecting of uranium deposits, because of the ease of application of the emanation method, the speed of field operations, and the larger volume of data obtained. Emanometric prospecting was carried out with Ambronn electrometers in various parts of Argentina. Examples are given of use of the emanometric method to investigate the continuity of uranium mineralization, including the cases of the "Rodolfo" (Córboda), "Los Adobes" (Chubut) and "Cuesta de Huaco" (San Juan) deposits, and to direct trial drillings and logging in areas where the mineralized strata lay under a thick alluvial cover. Subsequent exploratory work (drilling and mining) has confirmed the results obtained with this method. (D.L.C.)

37414 (A/CONF.28/P/844) URANIUM RESOURCES AND RECOVERY PROCESS IN JAPAN. PART I. URANIUM RESOURCES IN JAPAN. Motoo Sato, Hidekatsu Misawa, and Fumio Togo. PART 2. A NEW PROCESS FOR RECOVERY OF URANIUM FROM LOW GRADE ORE. T. Yamashita, T. Murase, T. Amanuma, and K. Hashimoto (Atomic Fuel Corp., Tokyo). May 1964. 20p.

Systematic prospecting showed that the uranium ore reserve containing more than 0.01% U_3O_8 is 3,000,000 tons of average grade 0.06% and with total recoverable U content of about 2000 tons. Since there are many areas in Japan with geologic conditions similar to Ningyo-toge, where the presently-known ore reserve is concentrated, future prospecting is expected to create a sharp increase in the known reserve. Although the U ores in Japan are low grade, it is expected that they may be competitively mined by hydraulic methods, since they consist of very loosely cemented conglomerates and arkose, the U minerals occurring as fine grained crystals in the soft and porous parts and being thus easily soluble in acid. The developed U recovery process is outlined. (M.J.T.)

37415 (A/CONF.28/P/883) LE GISEMENT GABONAIS DE MOUNANA. (The Mounana Deposit of Gabon). (France. Ministère de l'Economie Nationale du Plan et des Mines). May 1964. 3p.

The uranium ore deposit in Mounana is briefly described, together with the chemical concentration of the mineral. Around 120 tons of concentrate are produced each month. (D.C.W.)

37416 URANIUM, THORIUM, POTASSIUM AND CARBON IN SOME BLACK SHALES FROM THE SOUTH WALES COALFIELD. T. W. Bloxam (University Coll., Swansea, Wales, U. K.). Geochim. Cosmochim. Acta, 28: 1177-85 (July 1964).

Carboniferous black shales from the lower and middle coal measures of the South Wales Coalfield were analyzed for uranium, thorium, potassium, and carbon. In the 32 samples investigated the average values for uranium and thorium are 4.0 and 12.3 ppm respectively, and the Th/U ratio 3.2. Potassium averages 3.2% and organic carbon 1.2%. The amount of uranium in the samples increases with the organic carbon content, but in general shows an inverse relationship towards thorium and potassium. (auth)

37417 URANIUM DISSEMINATIONS AND VEIN FILLINGS IN IRON ORES OF NORTHERN UPPLAND, CENTRAL SWEDEN. E. Welin. Geol. Foren. Stockholm Forh., 86: 51-82(Mar. 31, 1964).

Uranium mineralizations of three different paragenetic types were found in the iron ores of Uppland in the east of Central Sweden. The oldest uranium mineralizations were formed at the close of the Late Svecofennian palingenic processes at 1785 m.y. and consist of disseminated uraninite precipitated by an oxidation-reduction process in skarn ores. Another mineralization occurred in the fissured bedrock at 1585 m.y., and resulted in the formation of pitchblende, hematite, and some simple sulfides in a gangue of chlorite, calcite, and quartz. Also at this period a quartz-breccia with pitchblende and minor amounts of bornite, chalcopyrite, galena and hematite was formed. The younger period of uranium mineralization is supposedly related to a slight tectonic deformation of the Svecofennian rocks due to the emplacement of the Gothian granites and a precipitation of pitchblende in chemically reactive ferriferous rocks. (Atom Dokumentation, Vol. 6, No. 11, June 1964)

37418 REMARKS ON THE GENESIS OF HYDROTHERMAL URANIUM DEPOSITS. Jerzy Borucki. Przeglad Geol., 12: 267-70(June 1964). (In Polish)

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Refer also to abstracts 37393 and 38450.

37419 (A/CONF.28/P/27) A MEASUREMENT OF THE OCCURRENCE OF MINIMUM DILUTION RATES FOR STACK EFFLUENTS IN THE ATMOSPHERE. P. J. Barry (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.). May 1964. 7p.

Atmospheric diffusion rates were measured continuously at four sampling positions in the vicinity of a single stack at the Chalk River Nuclear Laboratories. The dilution of the cloud or plume of radioactive pollutants as it passes downwind from the source was analyzed. Information is given on site, sampling instruments and methods, and results obtained. (N.W.R.)

37420 (A/CONF.28/P/64) IRRADIATED FUEL TRANSPORT COSTS AND MAINTENANCE COSTS IN CHEMICAL REPROCESSING PLANT. Yves Sousselier (France. Commissariat à l'Energie Atomique, Paris). May 1964. 13p.

The transport of irradiated uranium between the Chinon reactors and the reprocessing plant of La Hague and between research reactors and foreign reprocessing plants was studied. The results indicate that costs can be reduced either by combining rail and road transport or by increasing the capacities of the transport containers. An evaluation of the maintenance costs of a reprocessing plant indicates that it runs to about 6% of the total investment, comparable to that for a conventional chemical plant. (D.C.W.)

37421 (A/CONF.28/P/83) MARCOULE SPENT FUEL PROCESSING PLANT ELEMENTS OF SAFETY AFTER SIX YEARS' OPERATION. Jean Rodier, Claude Jouannaud, and Edmond Mazaury (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 14p.

The safety experience of the Marcoule irradiated fuel reprocessing plant is reviewed from the standpoint of conventional and radiation protection. Both design and psychological factors in safety are considered, and the organization and experience of health physics are described. The incidents occurring during the operation of the plant are described. (D.L.C.)

37422 (A/CONF.28/P/184) EXPERIENCE IN THE TRANSPORT OF IRRADIATED FUEL. N. F. C. Bishop (United Kingdom Atomic Energy Authority. Production Group, Risley, Lancs, England), J. C. Egan, and W. W. Marshall. May 1964. 14p.

Containers and procedures used for the routine transport of irradiated fuel elements within England and overseas are described. (T.F.H.)

37423 (A/CONF.28/P/378) ATOMIC SHIPS SAFETY PROBLEMS. V. I. Neganov, B. G. Pologikh, and J. V. Sivintsev (U.S.S.R.). May 1964. 16p.

Calculations and theoretical conclusions are presented, which indicate that the basic recommendations with respect to atomic-powered ships contained in the International Convention for the Safety of Life at Sea 1960 can be successfully compiled on the icebreaker, Lenin. Specific data obtained in the course of the practical operation of the atomic plant of the icebreaker are shown. They confirm the practicability of the theoretical calculations. The possible radiation hazards resulting from the collision of an atomic-powered ship with other ships are discussed. Calculations are included of the possible outlet of radioactive fission products from the primary circuit in the case of moderate leakages or in the case of such situations as bursting of the pipe line in the primary circuit, when the reactor core will be left without water. Evaluation is made of the amount of core destruction that can be caused by the afterheat release in the uranium. (auth)

37424 (A/CONF.28/P/379) THE WAYS TO SOLVE IN THE USSR THE PROBLEM OF SANITARY PROTECTION OF THE ENVIRONMENT FROM RADIOACTIVE CONTAMINATION. F. G. Krotkov, A. N. Marei, A. S. Belitskii, A. S. Zykova, A. I. Ryzhov, and D. A. Celidovkin (U.S.S.R.). May 1964. 7p.

The problem of sanitary protection of reservoirs, underground waters, the atmosphere, and soil from contamination with radioactive waste has assumed in the Soviet Union a tremendous nationwide importance. It is aimed at ensuring radiation safety to the population. The sanitary requirements presented to the distribution of enterprises for the extraction, processing and use of nuclear fuel, the conditions for the discharge of radioactive waste into the atmosphere and the permissible doses of radioactive substances in the air, reservoirs and subterranean sources of water supply are governed by unified sanitary regulations published by the sanitary inspection bodies of the Ministry of Health Protection which have the force of law. The principle underlying this problem is to prevent the contamination of the environment with radioactive substances and to keep the population out of contact with them. This is achieved by employing a differentiated approach to the utilization of various methods depending on the type of enterprise and the nature of radioactive waste. Among the principal ones are an all-round reduction in the amount of liquid and gaseous wastes to be removed, their localization at the place of production, measures for their effective dispersement and deconcentration, and the arrangement of sanitary protection belts, which isolate the population from them. The problem of sanitary protection of the environment in the vicinity of operating atomic reactors and atomic-electric power plants is being successfully solved along various lines. Reliable burial of waste is of especial interest from the viewpoint of hygiene. Although these measures involve a certain capital outlay they give a good sanitary effect which is of decisive importance in this problem. As a result, a contamination hazard has been considerably reduced as regards subterranean water supply sources and reservoirs and the atmospheric air near the ground. The tasks that face specialists in this sphere are to improve still more the methods called upon to ensure radiation safety for the population. (auth)

37425 (A/CONF.28/P/422) TRANSPORT OF IRRADIATED NUCLEAR FUEL ON THE EUROPEAN CONTINENT. F. R. Marcus and J. Asyee (European Company for the Chemical Processing of Irradiated Fuels, Mol, Belgium). May 1964. 18p.

A description is given of the present status of irradiated fuel transport in Continental Europe, its administrative, technical, and economic aspects, and its influence on fuel cycle costs. Transport of irradiated fuel, of processed fissile material, and possibly of waste material between different countries on the Continent will become routine

within a few years. Since 1963, MTR fuel elements have been transported routinely from the Continent for processing. Bulk shipments from the first power reactors have not yet begun but it is anticipated that 270 tons of irradiated fuel will be unloaded from Continental power reactors before 1968. A major part of this fuel is of sufficiently high value to economically justify its reprocessing and thus increasing fuel shipments are anticipated. A brief survey is made of national legislation and transport regulations, as well as procedures necessary for transport approval as laid down in a number of European countries. International regulations, and their underlying safety principles, are mentioned and their importance in achieving uniform application and uniform cask design is discussed. Casks conforming with the regulations have been manufactured for a number of Continental reactors. Parameters governing cask design arise from regulatory requirements such as fuel temperature limitation during accident conditions, which tend to increase overall transport costs. On the other hand, improvements in cask design or in cask utilization, for example, where casks are developed to serve more than one reactor, can achieve a reduction in transport costs. Factors affecting cask payload are described in view of its bearing on transport economy. Tariffs are indicated for rail and road transport of irradiated fuel. Insurance cover against nuclear damage to third parties is available through insurance pools, and premiums are quoted. An estimate of overall transport costs together with possible processing tariffs for near-natural uranium indicate that routine shipments to centrally located processing plants would be reasonable. The influence of transport charges on the total fuel cycle cost is shown. (auth)

37426 (A/CONF.28/P/547) LIMITATION OF EXPOSURE TO WORKERS IN RADIATION EMERGENCIES. (International Labour Office, Geneva). May 1964. 13p.

Radiation emergency conditions are defined. The use of a criterion of degree of urgency rather than a rigid exposure limit in operational decisions is discussed. A 12-rem planned emergency exposure limit is suggested. Situations where rescue workers would receive a higher dose are considered, and the need for educating workers for responsible decisions in such situations is stressed. (M.J.T.)

37427 (A/CONF.28/P/788) HEALTH AND SAFETY PRACTICE AND MANAGEMENT IN ATOMIC ENERGY OPERATIONS IN INDIA. A. S. Rao, S. D. Soman, and P. R. Kamath (India. Atomic Energy Establishment, Trombay). May 1964. 18p.

Data collected for evolving an Indian Standard Man and development of safety standards for general population as well as occupational personnel are presented. Selection of sites for power reactors in India take due considerations of fission product releases from different types of reactors on site, the environmental population and utilization of the environment in the region of 1–30 miles from site, and the acceptable site radiological burden. National practices for siting of power reactors, planning of preoperational surveys, and management of environmental problems arising out of credible accidents are described. Experiences of radiation exposure and control in uranium mines and thorium processing plants are given. Safety management of Trombay operations are given in some detail. Hazard evaluation of reactors and processing plants are carried out, and measures are recommended to improve safety of operations. Experiences of normal operations as well as some unusual incidents in reactors are discussed, and training and emergency programs are outlined. Environmental monitoring surveys are carried out as a routine for presence of natural, induced or fission product radioactivity and build up of radioactivity through operational release. Environmental monitoring techniques and data as well as tracer trials carried out for study of movement of discharged effluent activity are given. Internal contamination studies of persons exposed to radiation are carried out. Whole body measurement techniques are developed for specific as well as total internal contamination. Radiochemical examination of urine is made as a routine and recommendations made to avoid over exposure of personnel. Data of human exposure for different radionuclides over years are presented, and recent radiochemical methods developed for the estimation of ^{228}Ra, ^{224}Ra, ^{232}Th, ^{60}Co, ^{131}I, ^{32}P, and other nuclides in bioassay and environmental samples are outlined. (auth)

37428 (A/CONF.28/P/849) HAZARD EVALUATION OF RADIOACTIVE CONTAMINATION OF SEA AND DECONTAMINATION OF RADIOACTIVITY IN FRESH WATER. Yoshio Hiyama (Tokyo Univ. Fisheries Inst.), Masamichi Saiki, Hiroshi Kamada, Taku Koyanagi, Yasuo Kurosawa, and Y. Hiyama. May 1964. 15p.

The experimental analysis of the quantitative relation in the levels of radioactive contamination between sea water and organisms on the elements thought to be important in the waste disposal problem, such as Cs, Sr, I, Co, Zn, Cd, Fe, Ru, and Ce, is discussed. As a result of numerous rearing experiments it was possible to know the level of the concentration of a certain radionuclide in a certain tissue of an organism by knowing the concentration of it in the sea water and how long it was in that environment. The concentration factors, a ratio of the concentration of an element in a tissue of an organism to that of sea water, were obtained during the rearing experiments. The equilibrium values of the concentration factor obtained by this series of experiments were compared with those which were obtained by chemical analysis of the stable and radioactive elements by previous workers. A way to control and to monitor the radioactive contamination of the sea is described. Studies based on experiments on the relation of radioactivity among water sources (river water, etc.), service water (drinking, etc.) and sewage, environmental behavior of radionuclides, and the various aspects of radiological decontamination are also discussed. Behavior and concentrations of ^{137}Cs and ^{90}Sr in fresh water in Japan, the relation of radioactivity between air and sewage, and radioactivity decontamination materials for drinking water are discussed. (C.E.S.)

37429 (A/CONF.28/P/870) SANITARY PROBLEMS RAISED BY THE ELIMINATION OF RADIOACTIVE WASTE AND BY NUCLEAR ACCIDENTS. Henri Jammet, David Mechali, and Marc Dousset (France. Commissariat a l'Energie Atomique, Paris). May 1964. 14p.

To be able to evaluate the risks run by the population and to fix tolerance limits for waste discharge, it is necessary to possess an exact knowledge of the course taken by the radioelements discharged, from their source until they reach man. The incorporation of radioelements in food cycles is the first risk to take into consideration. The factors involved in all stages of this transmission must be foreseen, whether they concern physical or biological media, because of their continuity and their interdependence. Finally, socio-economic and dietetic data must be collected in order that the risks and tolerance levels estimated are based on concrete and experimental rather than theoretical knowledge. The risk of nuclear accidents in the atomic industry, although very improbable, must be taken into consideration because of the seriousness of their consequences. The health problems arise in the field of

professional hygiene on the one hand and in that of public hygiene on the other. In the first field, the risk is two-fold and involves irradiation and contamination. The public sphere is reduced essentially to the risk of contamination by radioactive substances accidentally released in the surrounding medium. The health studies to be conducted in this field therefore include research not only on irradiation or contamination therapeutics but also on the transfer of radioelements from the accident site to man, mainly through food cycles, in their physical and in their biological components. Studies of this kind form the basis of decisions in the health field which would have to be taken in the case of an accident. (auth)

37430 (AD-431995) ANALYSIS OF SURVEY DATA. Summary of Final Report. Edward L. Hill, W. K. Grogan, R. O. Lyday, and H. G. Norment (Research Triangle Inst., Durham, N. C.). Feb. 15, 1964. Contract OCD-OS-62-144. 13p.

A review is presented of the National Fallout Shelter Survey findings to estimate probable error or reliability in the light of existing experimental data and theoretical considerations. The surveyed structures are categorized with respect to technical shielding characteristics and new information on shielding is evaluated for application to the computation of protection factors for the surveyed structures. The feasibility and importance of developing special computational programs for the several categories determined and additional programming for analysis of the survey data are discussed. (C.H.)

37431 (AD-438147) RADIOLOGICAL SAFETY MANUAL. A. G. Wedum (Army Biological Labs., Frederick, Md.). Dec. 1963. 89p.

Information is presented for the guidance of all personnel engaged in the use, handling, storage, disposal, or shipping of radioactive materials. Methods are outlined for personnel dosimetry and exposure records. (C.H.)

37432 (AD-439251) SHELTER OCCUPANCY STUDIES AT THE UNIVERSITY OF GEORGIA. Final Report, 1962–1963. John A. Hammes and R. Travis Osborne (Georgia. Univ., Athens). Dec. 31, 1963. Contract OCD-OS-62-226. 169p.

A detailed report is presented of a series of tests on the habitability of fallout shelters as presently stocked in accordance with the National Shelter Program. These studies surpassed in austerity all previous shelter research using civilians. Men, women, and children, age 7 to 70 years, participated in two-week confinement tests. (auth)

37433 (AD-600423) MOISTURE IN SURVIVAL SHELTERS. Summary of Research Report. (Florida. Univ., Gainesville. Engineering and Industrial Experiment Station). Apr. 27, 1964. 18p.

Results are summarized from a study of sources of moisture and condensate in occupied and unoccupied shelters including the effects of climate, ground water, permeability, ventilation, latent heat, dew point, and surface temperatures. An investigation of promising methods for reducing humidity, preventing leakage of moisture into shelters, and controlling moisture and condensate was conducted. Commercial dehumidifying apparatus for use in survival shelters was evaluated. Chemicals which might be suitable for the absorption of moisture and the control of shelter humidity were investigated. Comparative tests were performed on the basis of the information developed during the above evaluations. Conclusions were drawn and recommendations were made with respect to suitable apparatus and procedures necessary for control of humidity and moisture in survival shelters. (auth)

37434 (AD-600437) MOISTURE IN SURVIVAL SHELTERS. Final Report. F. M. Flanigan and Juan O. Gonzalez, Jr. (Florida. Univ., Gainesville. Engineering and Industrial Experiment Station). Apr. 1964. Contract OCD-OS-62-51. 131p.

An investigation was made into the sources of and the means of control of moisture in survival shelters. Moisture was found to originate within survival shelters as a result of the metabolic process of the occupants and by evaporation from exposed wetted surfaces. The principal modes for introduction of moisture were found to be gross leaks in the shelter structure, vapor migration through permeable walls, and the humidity contribution of the ventilation air. Methods of moisture control included prevention of ingress by improved water and vapor proofing of the exterior shelter surfaces, removal by means of excess ventilation air, and condensation with or without subsequent rejection of the resultant latent heat. No satisfactory methods or devices were found for condensing or absorbing water vapor when the resultant latent heat was liberated within the space to be conditioned. Both theoretical considerations and practical demonstrations indicated that the effective temperature was invariably raised thereby. Methods evaluated included absorption by treated fibers and by chemical agents as well as drying by mechanically powered dehumidification devices. Water coils, employing cool water from constant temperature deep wells, were successful in condensing moisture from shelter atmospheres. Calculations indicate this method to be more efficient than cooling and dehumidification by compression refrigeration. Integral mechanical or chemical dehumidifiers may be employed to produce and maintain satisfactorily low humidity environments in unoccupied shelters only if steady state water leakage and vapor migration can be kept to low levels. Otherwise, shelter and surrounding earth are raised to and maintained at temperature levels prejudicial to survival if the shelter must be used. (auth)

37435 (AD-600751) THE AMERICAN PUBLIC AND THE FALLOUT-SHELTER ISSUE. A NINE-COMMUNITY SURVEY. VOLUME II. THE STUDY DESIGN AND THE STUDY COMMUNITIES. Gene N. Levine and John Modell (Columbia Univ., New York. Bureau of Applied Social Research). Oct. 1963. Contract OCD-OS-62-71. 91p.

During the winter of 1962 and 1963 a survey was conducted in 9 communities to ascertain the opinions of the general public on the fallout shelter issue. The study design is outlined and descriptions are presented of the communities in which interviews were made. The development of the basic questionnaire used in the interviews is also discussed. (C.H.)

37436 (AED-C-02-05) RADIATION EFFECTS ON FOOD (INCL. RADIOACTIVE CONTAMINATION). Series C: Bibliographies. Hanna Lueck, comp. (Germany. Forschungsanstalt fur Lebensmittelchemie, Munich). Mar. 1964. 122p.

Three hundred and twenty-one references are presented to the international literature on radiation effects on foods and radioactive contamination of foods. Author and subject indexes and an index of radionuclides are included. (C.H.)

37437 (AEET/HP/SM-1) PERSONNEL DECONTAMINATION. I. S. Bhat, P. R. Kamath, and S. Somasundaram

(India. Atomic Energy Establishment, Trombay). Oct. 1963. 19p.

Causes of personnel contamination during the handling of radioactive materials are reviewed. Procedures are outlined for the decontamination of personnel after external or internal contamination. Data are appended on the maximum permissible body burden of commonly used radioisotopes, complexing agents used for the reduction of internal contamination, maximum permissible levels of surface contamination, and detergents commonly used for decontamination. (C.H.)

37438 (AERE-R-4680) A SPECIAL PROGRAMME OF AIR SAMPLING IN SELECTED AREAS OF A.E.R.E. HARWELL. R. J. Sherwood and D. C. Stevens (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). July 1964. 20p.

Results are presented from a 4-month program of air sampling in a few operating areas of A.E.R.E. The results confirm previously reported work which suggested that the concentration of activity in the air of a working area is far from constant in either time or space, and, further, that many results are not even samples in a statistical sense in that they do not represent a particle population. (C.H.)

37439 (CONF-337-7) MONITORING THE OFF-SITE GASEOUS RELEASES AT R.C.N. RESEARCH ESTABLISHMENT. J. R. D. Stoute (Reactor Centrum Nederland, Petten). [nd]. 7p.

From International Conference on Radioactive Pollution of Gaseous Media, Saclay, France, Nov. 1963.

Procedures used at the Reactor Centrum Nederland Research Establishment, Petten, the Netherlands, for monitoring gaseous releases from the reactor, chemistry building, and dismantling hotlab are outlined. The gaseous effluents are measured at points where little dilution of the contamination has occurred. Provisions are made for enlisting the help of village constables for environmental monitoring in case of an accidental release. Periodic analyses of filters from the emergency monitors are used as a check on environmental contamination in the environs. (C.H.)

37440 (NP-14208(Vol.I)) A PROTOTYPE CIVIL DEFENSE MANUAL FOR RADIOLOGICAL DECONTAMINATION OF MUNICIPALITIES. SECOND EDITION. VOLUME I. DECONTAMINATION PLANNING. Mario V. Cammarano, C. Herbert Wheeler, Jr., and G. S. Wing (Curtiss-Wright Corp. Curtiss Div., Caldwell, N. J.). May 1964. Contract OCD-05-62-279. 217p.

The physical phenomena associated with nuclear detonations and the biological effects of the associated radioactive fallout are reviewed. Both pre-attack and post-attack analytical planning procedures are discussed for the radiological decontamination of municipalities. The efficiencies of decontamination methods and equipment are evaluated in terms of effectiveness and human effort, fuel, and water requirements. A concept is developed for the sub-division of large municipalities into smaller, operational zones for decontamination operations. A zone may consist of an existing school district, precinct, or ward, depending upon local conditions. A post-attack scenario is presented to describe conditions that may be encountered in various areas surrounding and downwind from a nuclear detonation. Procedures are described for the decontamination of structures and areas that have been made dangerous by fallout. (C.H.)

37441 (NP-14208(Vol.II)) A PROTOTYPE CIVIL DEFENSE MANUAL FOR RADIOLOGICAL DECONTAMINATION OF MUNICIPALITIES. SECOND EDITION. VOLUME II. DECONTAMINATION OPERATIONS. Mario V. Cammarano, C. Herbert Wheeler, Jr., and G. Sherman Wing (Curtiss-Wright Corp. Curtiss Div., Caldwell, N. J.). May 1964. Contract OCD-OS-62-279. 125p.

Practical, operational information is presented on the decontamination of radioactive fallout. The types of surfaces which will be encountered, the methods best suited to their decontamination, and the special considerations required by cold weather are discussed. Three basic principles of fallout decontamination are reviewed including cleaning the surface, removing the surface, and covering the surface. The various methods for achieving decontamination are categorized as wet or dry methods, and are discussed individually in detail. Team make-ups, equipment requirements, and operational procedures for the decontamination of municipalities from fallout from nuclear detonations are included. (C.H.)

37442 (ORNL-3665) APPLIED HEALTH PHYSICS ANNUAL REPORT FOR 1963. J. C. Hart, ed. (Oak Ridge National Lab., Tenn.). Aug. 1964. Contract W-7405-eng-26. 75p.

The waste releases from the Laboratory, atmospheric and liquid, were such that the concentration of radioactive materials in the environs were well below the maximum levels recommended by the NCRP and FRC. There was a reduction in the number of beta curies released via White Oak Creek to Clinch River, 469 curies in 1963 compared with 1436 curies in 1962. Also, there was a reduction in the average concentration of ^{131}I in milk samples processed, 13 pc/liter in 1963 compared with 96 pc/liter in 1962. The concentration of radioactive materials in the air and the background readings for 1963 did not show a significant change as compared with 1962. One employee received an exposure to tritium which resulted in an estimated body deposition of approximately 87 mc. The indicated dose to the whole body was estimated to result in a total dose of about 14 rem. Forty-three unusual occurrences were recorded during 1963 as compared with 55 for 1962. (auth)

37443 (ORNL-NSIC-3) CURRENT PRACTICES IN THE RELEASE AND MONITORING OF ^{131}I AT NRTS, HANFORD, SAVANNAH RIVER, AND ORNL. K. E. Cowser (Oak Ridge National Lab., Tenn.). Aug. 11, 1964. Contract W-7405-eng-26. 111p.

A study was made of the current practices in the release and monitoring of ^{131}I at the National Reactor Testing Station, Hanford Atomic Products Operation, Savannah River Plant, and Oak Ridge National Laboratory. Analyses were made of the principal sources of ^{131}I, methods of treatment prior to release, quantities released to the environment, criteria for release, sampling equipment and analytical techniques, and sensitivity of analytical techniques, and estimates were made of human exposure based on quantities detected (including nuclear test fallout) in environmental media. During 1962, the average release of ^{131}I to the atmosphere ranged from 0.045 to 0.35 curies per day. The average annual concentrations of ^{131}I in the atmosphere and in milk from cows grazing along the perimeter of the controlled areas were $<10^{-7}$ $\mu\mu c$/cc and <100 $\mu\mu c$/liter, respectively; fallout of nuclear debris from weapons tests was the major contributor of ^{131}I. Estimates of human intake did not exceed the 100 $\mu\mu c$/day limit established by the radiation protection guides published by the Federal Radiation Council. The installations are described and conclusions

are drawn, based on these findings and the work of others, regarding the release of radioiodine, the chemical and physical forms at the point of release, and changes occurring in form during sojourn in the environment. The monitoring techniques investigated, in use, and most applicable for radioiodine are discussed, and information is presented on the deposition of radioiodine from contaminated clouds and subsequent intake by man. (auth)

37444 (ORNL-TM-797) BUILDING 3019 EMERGENCY MANUAL. (Oak Ridge National Lab., Tenn.). [196?]. Contract W-7405-eng-26. 69p.

The emergency plan for Building 3019, the Radiochemical Processing Pilot Plant, is described as well as the duties of all personnel in the event of an emergency involving either radioactivity or "normal" industrial hazards. The operation of the plan is illustrated by two test cases, a fire and a criticality accident. Details of the building containment, protective systems, and emergency instrumentation are included. (auth)

37445 (RFP-363) CRITICALITY RECOMMENDATIONS FOR BUILDING 71—PROCESS CHEMISTRY. B. B. Ernst and H. W. King (Dow Chemical Co. Rocky Flats Div., Golden, Colo.). [1964]. Contract AT(29-1)-1106. 79p.

Criticality limits are given for Pu metal and its compounds and solutions in the Process Chemistry Areas in Building 71. (D.L.C.)

37446 (TID-21081) FALLOUT IN THE 1963 TEEN-AGE DIET. Final Report. (Consumers Union of United States, Inc., Mount Vernon, N. Y.). Feb. 20, 1964. Contract AT(30-1)-3182. 16p.

The content of Ca, ^{90}Sr, ^{89}Sr, and ^{137}Cs in teen-age diets was determined during 1963 in 22 key cities throughout the U. S. Home economists surveyed the eating patterns of teen-agers in their localities and prepared menus on the basis of these surveys. The ^{90}Sr and ^{89}Sr levels in 1963 reached about 20% of the Federal Radiation Council's guidance levels, and were roughly twice the 1962 average. The ^{137}Cs average level reached 7.5% of the permissible limits set forth for the general population and was about three times that recorded in 1962. The highest peaks for ^{90}Sr and ^{89}Sr occurred in June through August and the highest peaks for ^{137}Cs were in July and August. (C.H.)

37447 (USNRDL-TR-761) SKIN CONTACT TRANSFER OF TRITIUM FROM BRASS. M. E. Hutchin and B. E. Vaughan (Naval Radiological Defense Lab., San Francisco). June 29, 1964. 18p. (AD-603309)

Results are reported from studies that show that contact of skin with contaminated metal can facilitate the transfer of tritium, that the radioactivity absorbed onto the skin enters the body water, and that it follows the metabolic pattern of tritium entering by other modes. Tritium in the skin was determined after converting all forms to tritiated water by dry combustion. Standardized exposures were checked by liquid scintillation counting. Curves for the disappearance of tritium in the skin could be resolved into 0.3, 3, and 14 day half-times, and after 15 days there was little difference between wet and dry tissues. The accumulative excretion curves, based on the measured half-time value of 5.5 days for urine radioactivity, showed that substantially all of the skin radioactivity can be accounted for in body water by 28 days. (auth)

37448 (AEC-tr-6398(p.199-204)) ON THE MEASUREMENT OF THE GAMMA RAY DOSE ACCORDING TO THE VARIATION OF THE OPTICAL ACTIVITY OF CARBOHYDRATES. Sh. A. Ablaev, V. V. Generalova, and S. V. Starodubtsev. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 159-?(1961).

Methods of chemical dosimetry are discussed. The use of sucrose and glucose for gamma dosimetry is suggested because of sensitivity and freedom from subsequent complex treatment; experimental results are given for doses of 0 to 200 MR from polarimeter observations. (R.E.U.)

37449 (ANL-Trans-76) A CALCULATION OF THE MAXIMUM CONCENTRATION ON THE GROUND AND ITS DISTANCE FROM THE SOURCE. K. Imai. Translated for Argonne National Lab., Ill., from p.171-2 of report JAERI-5006. 1962. 7p.

Formulas are presented for use in calculations of the maximum concentration of radioactivity on the ground at various down-wind distances from a reactor stack. (C.H.)

37450 (JPRS-26021) ORGANIZATION OF MEDICAL COUNTERMEASURES AGAINST RADIATION ACCIDENTS DUE TO EQUIPMENT DAMAGE OR BREAKDOWN. K. Neumeister. Translated from Deut. Gesundheitsw., No. 28, 1293-7(July 9, 1964). (TT-64-41291)

Measures are outlined for handling radiation accidents in radioisotope laboratories. The handling of disasters such as nuclear weapons explosions or serious reactor accidents is discussed briefly. Emphasis is placed on the organization of medical personnel. (C.H.)

37451 DISTRIBUTION AND ELIMINATION OF POLONIUM. D. Duric, M. Kilibarda, and D. Panov (Inst. of Occupational Medicine, Socialist Republic of Serbia, Belgrade). Arhiv Hig. Rada i Toksikol., 14: 317-25 (1964).

Determination of radioactive polonium in urine of over 300 miners from the Yugoslav uranium mines confirms that this is a good method for monitoring exposure to radiation in occupational medicine of uranium miners. No detailed data are given. (auth)

37452 CLEARANCE OF INSOLUBLE DUST FROM THE LOWER RESPIRATORY TRACT. Paul E. Morrow, F. Raymond Gibb, and Leigh Johnson (Univ. of Rochester, N. Y.). Health Phys., 10: 543-55(Aug. 1964).

Studies of the clearance of dusts of low solubility from the lower respiratory tracts of dogs utilizing in vivo counting, revealed that for a given aerosolized substance there was a consistent clearance pattern, but among different substances, e.g. ferric oxide, manganic oxide, mercuric oxide, barium sulfate and uranium dioxide, the rate of LRT clearance differs widely during the second phase, i.e., after the first few days. Evidence obtained from excretion data and ultrafiltration studies suggests these differences were determined by the respective in vivo solubilities of the materials studied. Variations in the amount or particle size of a particular aerosol altered the quantitative aspects of both clearance phases but neither appeared to affect the rates of dust clearance in either phase. (auth)

37453 INSURANCE AGAINST NUCLEAR RISKS. Theodore C. Pontzen. Ind. At., 8: Nos. 5-6, 79-88(1964). (In French)

The viewpoints of the insurer and insuree in insurance against nuclear risks are compared and contrasted in order to give an indication of the problems in this type of insurance. The particular problems raised for reactor and other nuclear installations are shown. The possibility of reconciling the various viewpoints is discussed. (J.S.R.)

37454 IODINE-131 IN FOODS. Richard J. Velten (Robert A. Taft Sanitary Engineering Center, Cincinnati). J. Assoc. Offic. Agr. Chemists, 47: 681-4(Aug. 1964).

Two collaborative studies were conducted on the determination of ^{131}I in milk. In the first study, eight collaborators analyzed four samples ranging from 58 to 227 pc/^{131}I, but results were inconclusive. In the second study, 15 collaborators reported results for two samples. Results were much better. A third study is planned, on the basis of which a method will be proposed for adoption. (auth)

37455 ADMINISTRATIVE EXPERIENCE WITH DECONTAMINATION OF VACATED RADIATION INSTALLATIONS. Morris Kleinfeld (New York State Dept. of Labor, New York) and Albert Abrahams. J. Occupational Med., 6: 255-61(June 1964).

Eleven contaminated radiation installations were studied. The highest level of contamination was found in radium-producing installations and the lowest level was found in research laboratories. The reasons for the more severe contamination in the radium-producing industry are given. The matter of responsibility for decontamination of vacated premises was specially highlighted in those instances where the owner responsible for the remaining contamination had removed his plant from the state and, hence, was no longer under the jurisdiction of its agency responsible for enforcement of the radiation regulations. In those instances where relatively low-level contamination continued to exist in vacated installations, the premises were regarded as a controlled area and new occupants were required to register, notwithstanding the fact that they used no radiation-producing equipment or material in their operation. A requirement that all firms handling sealed and unsealed radioactive sources be covered by insurance against the cost of decontamination was deemed to be desirable. A good correlation was found between the gaseous radon generated from radium sources and deposited radon daughter products. There was no correlation between airborne and surface radioactive contamination for other isotopes, supporting the findings of previous investigators. The guidelines that the state labor department utilized for decontamination in the 11 contaminated radiation installations proved practical and, in the absence of standards that are scientifically validated, they will serve as working rules. (auth)

37456 DYNAMICS OF TRANSPORT OF FISSION PRODUCTS BY ATMOSPHERIC PRECIPITATION. Vilem Santholzer (Charles Univ., Hradci Krâlove, Czechoslovakia). Jaderna Energie, 10: 251-3(1964). (In Czech.)

On the basis of systematic measurements of artificial radioactivity of atmospheric precipitation in the period of megaton nuclear tests in the years 1961–1962 as well as in the period after the test stop (1963 and the beginning of 1964) it was possible to deduce simple conceptions of the dynamics of the transport of fission products by atmospheric precipitation. It is shown that a definite activity has not been surpassed, because for a specific activity A the following relation is valid. $A \cdot h = \text{const.}$, h standing for the intensity of precipitation. In a period in which only stratospheric fallout manifests itself the relation A = const is valid, and consequently the specific activity is independent of the intensity of precipitation. In the precipitation of little intensity, radioactive dust in the troposphere (dry fallout) manifested itself to a considerable extent. Between these extreme cases there are still others, that are explained on the basis of simple conceptions of the transport of aerosol by rain water. (auth)

37457 INCREASE IN THE CAESIUM-137 CONTENT OF MAN DUE TO RADIOACTIVE FALL-OUT, 1962-64. J. Rundo and D. Newton (Atomic Energy Research Establishment, Harwell, Didcot, Eng.). Nature, 203: 537-8 (Aug. 1, 1964).

The results of measurements of ^{137}Cs in human beings during April 1962–April 1964 are reported. Reasons for differences between the two subjects who showed the lowest and highest values are discussed. It is noted that the radiation dose rates from the ^{137}Cs were small compared with the dose rate from natural sources. (P.C.H.)

37458 QUALITY CONTROL CROSS-CHECK ANALYSES OF GAMMA EMITTERS IN MILK, DIVISION OF RADIOLOGICAL HEALTH, APRIL–OCTOBER 1963. Marvin Rosenstein, Kenneth H. Falter, and Abraham S. Goldin. Radiol. Health Data, 5: No. 8, 377-82(Aug. 1964).

Cross-check milk samples were analyzed in triplicate for ^{131}I, ^{140}Ba, ^{137}Cs, and K by γ scintillation spectroscope at 5 laboratories from April through Oct. 1963. Good agreement was found for ^{131}I and ^{140}Ba. Results for the first part of the period for ^{137}Cs indicated that improvement was needed. Results for K were not acceptable. (C.H.)

37459 SYMPOSIUM ON THE TECHNICAL PROBLEMS OF RADIATION PROTECTION, WARSAW, 25-29 SEPTEMBER 1962. PART II. (Poland. Biuro Pelnomocnika Rzadu do Spraw Wykorzystania Energii Jadrowej. Centralne Laboratorium Ochrony Radiologicznej, Warsaw). 251p.

In Polish, German, and Russian.

The 18 papers compiled in Part II of the Symposium dealt with environmental and internal contamination and the processing and disposal of radioactive wastes. Separate abstracts were prepared for each paper. (J.S.R.)

For abstracts of individual papers see: 37388, 37389, 37390, 37461, 37462, 37463, 37464, 37465, 37466, 37467, 37544, 37545, 38692, 38693, 38694, 38695, 38696, and 38697.

37460 ORGANIZATION FOR PROTECTION AGAINST IONIZING RADIATION IN THE PRL (POLISH PEOPLE'S REPUBLIC). J. Rotnicki (Administrative Bureau for Utilization of Nuclear Energy, Warsaw). Symp. Tech. Zagadnien Ochrony Promieniowaniem, Warsaw, 1-17(1962). (In Polish)

The task of radiation protection monitoring of the entire population of the Polish People's Republic was divided between the Ministry for Health and Social Welfare and the Authority of the Government for the Utilization of Atomic Energy. The tasks given in this area to each agency and the organization of the agencies are described. In particular, the organization for the supervision of the utilization of radioactive materials, monitoring, and the removal of radioactive wastes is discussed. The organization of the research and scientific studies in relation to the technical problems of radiation monitoring are reported. (tr-auth)

37461 EFFECTIVENESS OF AEROSOL FILTRATION OF SHORT-LIVED PRODUCTS OF RADON ON FPP-15 MEMBRANE. I. I. Kornilenko, V. I. Zybin, and V. I. Glagolev. Symp. Tech. Zagadnien Ochrony Promieniowaniem, Warsaw, 293-326(1962). (In Russian)

The results of studies on separation capacity of the filter FPP-15 with respect to aerosols consisting of short-lived Rn daughter products are reported. The air velocities used were from 1 to 8 m/hr and the Rn concentration in the aerosol chamber from 7×10^{-13} to 6×10^{-10} c/l. The mea-

surement results indicated that the FPP-15 type filter has a high removal efficiency for Rn daughter products (at the air velocities used it is not less than 99%). With the increase of the dust concentration in the air, the removal capacity decreased to 85 to 90%. The investigations with charcoal filters showed that, of the RaA aerosols arising in the air, a small fraction (about 0.5%) penetrates easily through the FPP filter. (tr-auth)

37462 SEPARATION OF RADIOIODINE VAPORS FROM AIR. W. Ullmann (Institut für Staubforschung und Radioaktive Schwebstoffe, Berlin). Symp. Tech. Zagadnien Ochrony Promieniowaniem, Warsaw, 327-37(1962). (In German)

The construction of apparatus for the measurement of the separation efficiency and the flow resistance of iodine-131 filters is described in detail. The devices and the measurement methods used permit the investigation of iodine filters at very low iodine vapor concentrations and different operating conditions. The measurement results obtained for the separator agents used (5 different activated charcoals, silica gel, and fillers of silver and silver nitrate) are reported. Conclusions on the practical utilization of iodine filters are given on the basis of economic considerations. (tr-auth)

37463 MEASUREMENT OF CONCENTRATION OF PLUTONIUM (Pu-239) IN AIR. T. Deszczak (Inst. of Nuclear Research, Warsaw). Symp. Tech. Zagadnien Ochrony Promieniowaniem, Warsaw, 347-54(1962). (In Polish)

A brief critical review was given of the methods for the elimination of background in the measurement of small concentrations of α-active isotopes in the air. The results of the measurements of the dust samples from four different filters, which were carried out with a semi-conductor and a 200-channel analyzer, are reported. The applicability of the filters for spectrometric measurements of the Pu concentration in air was analyzed. (tr-auth)

37464 CALCULATION OF PERMISSIBLE CONCENTRATION LIMITS OF RADIOACTIVE GASES IN THE AIR OF WORK AREAS AND IN THE ATMOSPHERE FOR VARIOUS EXPOSURE CONDITIONS. G. M. Obaturov. Symp. Tech. Zagadnien Ochrony Promieniowaniem, Warsaw, 355-76(1962). (In Russian)

The calculations of the maximum permissible concentration were made for most radioactive gases in the laboratory air and in atmospheric air. Factors considered in the calculations included internal irradiation from the radioactive gases and from their decay products; volume of the work area, which affects the portion of γ radiation in the MPC magnitudes; radiological sensitivity of the individual human organs; and absorption of the β particles in various organs. Tables of the MPC values were compiled for the individual radioactive gases. All isotopes were grouped according to their half lives and radiation energy. The analytical methods for the different groups were given. The possibility of constructing an isodose gas dosimeter was discussed. The formulas for the calculation of irradiation of critical organs were given and the maximum half life for the isotopes forming the radioactive aerosols was determined. (tr-auth)

37465 INTERNAL CONTAMINATION AMONG PEOPLE WORKING WITH RADIOACTIVE PAINT PIGMENTS AND HYGIENIC-SANITARY LABOR ESTABLISHMENT CONDITIONS. D. Brykalski, W. Czosnowska, D. Depczyk, A. Gawronski, J. Liniecki, C. Rozycki, and T. Spodenkiewicz (Inst. for Labor Medicine, Radiological Protection Establishment, Lodz, Poland). Symp. Tech. Zagadnien Ochrony Promieniowaniem, Warsaw, 377-86(1962). (In Polish)

In connection with the use in Polish industry of radioactive paints containing ^{226}Ra and ^{90}Sr, the injury of personnel working with these pigments was investigated. The results of the studies on the incorporation of radioactive materials in 285 persons (about 75% of the injured) and the sanitary conditions of the work areas were reported. The content of ^{226}Ra was determined on the basis of an analysis of daily urine and feces samples and a ^{222}Rn determination in the exhaled air. The sanitary state of the operation using the radioactive luminescent paints was estimated on the basis of measurements of the surface contamination and the ^{226}Ra air concentration. (tr-auth)

37466 METHODS FOR ESTIMATING INTERNAL CONTAMINATION USED BY THE RADIOLOGICAL PROTECTION ESTABLISHMENT OF THE INSTITUTE OF LABOR MEDICINE IN LODZ. W. Czosnowska, A. Gawronski, W. Karniewicz, A. Kosterkiewicz, J. Liniecki, and T. Spodcnkiewicz (Inst. for Labor Medicine, Radiological Protection Establishment, Lodz, Poland). Symp. Tech. Zagadnien Ochrony Promieniowaniem, Warsaw, 387-401(1962). (In Polish)

For an estimation of the internal injury that is connected with work with radioactive luminescent paints containing ^{226}Ra and ^{90}Sr, a series of radiochemical and physical methods were used. On the basis of determinations of the content of these isotopes in daily urine and fecal samples collected under clinical conditions, the internal contamination can be estimated qualitatively or semi-quantitatively. The content determination of ^{222}Rn in the exhaled air gives a unique method for the determination of ^{226}Ra internal contamination. A method for the determination of Rn concentrations in the range from 5×10^{-14} to 10^{-11} c/l was perfected. This method permits Ra concentration determinations in the organism of more than 0.115 μg. In the final development stage, there is a device for the estimation of the internal contamination by a measurement of the radioactivity of the whole body as determined with a whole-body counter. (tr-auth)

37467 Sr-90 LEVELS IN HUMAN BONE IN POLAND, 1958–1961. J. Liniecki, W. Karniewicz, W. Czosnowska, and A. Kosterkiewicz (Inst. for Labor Medicine, Radiological Protection Establishment, Lodz, Poland). Symp. Tech. Zagadnien Ochrony Promieniowaniem, Warsaw, 402-17 (1962). (In Polish)

The determination of the ^{90}Sr level in human bones was carried out using the Volchok oxalate method with suitable modifications. Strontium-90 determinations were made on over 300 bone samples. A high level was found in the children's group, with the highest value for ages under 2 years. In the groups over 20 years of age, no variation of the ^{90}Sr level could be established. In 1960 some increase of the ^{90}Sr/g Ca was detected in all age groups in comparison with 1959. In opposition to the 1959 to 1960 period, no significant increase of the ^{90}Sr level in adults was found in Lodz. On the basis of the investigations of the ^{90}Sr concentration in foods and bones, problems of the kinetics of the chronic absorption of ^{90}Sr from foods were discussed. (tr-auth)

37468 RADIOLOGICAL EMERGENCY PROCEDURES FOR THE NON-SPECIALIST. Karl F. Oerlein (Defense Atomic Support Agency, Washington, D. C.). May 1964. 40p. $0.35(GPO).

The biological hazards of nuclear radiation are reviewed. Radiological emergency procedures are outlined for the non-specialist involved in an accident involving radioactive materials. (C.H.)

37469 SPECIFICATION FOR FILM BADGES FOR PERSONNEL RADIATION MONITORING. London, British Standards Institution, 1963. 12p.

The British Standard for establishing a size for monitoring film and the essential requirements for design of a suitable holder are presented. Specifications apply to badges consisting of photographic film packets, a combination of external filters, and a film holder in such a form as to provide a lightweight rugged radiation dosimeter for monitoring radiation dosed, including thermal neutrons, received by personnel. (H.M.G.)

37470 BACKGROUND INFORMATION ON ATOMIC POWER SAFETY. John F. Hogerton. New York, Atomic Industrial Forum, 1964. 51p. $1.00.

Reactor safety procedures are outlined. Radiation detection, measurement, and protection standards, control of radioactive material during routine operation, accident prevention, containment in the event of accident, the licensing and regulation of atomic power plants, and safety experience are considered. Specific reactor accidents are briefly discussed. The principles of atomic power and a description of several reactor types are included. (C.E.S.)

37471 FOOD HYGIENE AND RADIOACTIVITY. J. Morre and L. Richou (Service Veterinaire Sanitaire, Paris). p.1-57 of "Normes et Techniques." Paris, Association Vétérinaire d'Hygiène Alimentaire, [1964]. (In French)

The pertinent aspects of nuclear physics are summarized; and the organization and operation of a radiobiological laboratory are outlined, including design, personnel, and measurement apparatus and techniques. The activities of the radiobiologist are then defined. Control of ambient radioactivity, accidents, application of ionizing radiation in food technology, and the use of radioisotopes in biological laboratories are considered. (D.C.W.)

INSTRUMENTATION

General

Refer also to abstract 37599.

37472 (A/CONF.28/P/633) OPTIMUM DIGITAL INFORMATION TREATMENT AND NUCLEAR ENGINEERING INSTRUMENTATION. P. Kovanic (Ceskoslovenska Akademie Ved. Ustav Jaderneho Vyzkumu, Rez). May 1964. 15p.

The signals treated by nuclear physics and engineering instrumentation are subjected in many cases to statistical disturbances. These disturbances are due to the statistical nature of physical processes, information about which must be given by means of treatment of the input signals. The problem of the optimum treatment of information in the presence of statistical perturbations is solved theoretically by the theory of Wiener, which is directly applicable for instrumentation having a continuous physical quantity at their inputs and outputs. At high requirements on accuracy, the applicability of this type of apparatus and filter is limited. In addition, it is not always simple to design instrumentation that approximates the characteristics of an optimum mathematical model according to Wiener theory using real components. It is necessary, therefore, to use digital computers. Interesting results, (i.e., the relatively simple digital computer structure, the possibility to determine simply the theoretical accuracy limit, and at the same time the possibility of a "nearly complete" exploitation of the input information) were obtained using following algorithm: the input signal is a vector of a finite dimension. The components of this vector are given by the finite series of sums of non-random and random function values, the basic statistical parameters of the latter being given. The output signal is obtained as the scalar product of the input vector and the vector-operator. The components of the vector-operator are determined by the requirement of the given analytical accuracy, by the minimum result dispersion and by the type of the linear transformation applied to the input non-random function. Special cases of this problem are as follows: digital interpolation, extrapolation and filtration of the input values of the non-random function, its derivatives, integrals and/or its linear transformations. Fundamental theoretical results necessary for practical computations are mentioned. Examples of using this approximation in some nuclear physics and engineering problems are given. Accurate reactor power and period measurements, reactor prompt reactivity measurement using reactor kinetics equation, etc., are given as possible utilization regions. The necessity of a passage to digital computers increases with increasing accuracy requirements and with increases in the transformation complexity to be performed by the computer, which is especially affected by the statistical components of the input signal. (auth)

37473 (ASD-TDR-63-75) DESIGN CRITERIA FOR RADIATION-RESISTANT FLIGHT CONTROL SYSTEMS FOR AEROSPACE VEHICLES. Final Report. M. C. Chapman (Northrop Corp. Northrop Space Labs., Hawthorne, Calif.). Apr. 1963. Contract AF33(657)-7851. 137p. (AD-432234)

Data concerning the effects of the natural radiation in space on components of a general flight control system are presented. The radiation exposures for components inside a typical vehicle skin were determined. The feasibility and limitations of correlating space radiation effects to nuclear reactor data were investigated, and radiation effects on the flight control system are discussed for four representative missions in space. A test program and recommendations for further analyses are outlined, in order to remove some of the limitations inherent in the present state-of-the-art in the area of effects of space radiation on flight control systems for aerospace vehicles. (auth)

37474 (CLOR-27) USUNIECIE AWARII DEFEKTOSKOPU GUP-Co-50. (Correction of the Breakdown of GUP-Co-50 Defectoscope). St. Dyz and Z. Wanat (Poland. Biuro Pelnomocnika Rzadu do Spraw Wykorzystania Energii Jadrowej. Centralne Laboratorium Ochrony Radiologicznej, Warsaw). 1964. 16p.

The removal of the damage of the defectoscope GUP-Co-50 with Co-60 source, 14 C activity, is described. In the discussed accident, the Co-60 source got jammed in the hose joining the shielding container with the head of the defectoscope. The results of measurements of dose rates, surface contaminations, and individual doses received by employees removing the damage, are given. (auth)

37475 (IS-805) TEMPERATURE DISTRIBUTION IN A HOLLOW CYLINDRICAL MANOMETER COLUMN. Dale LeRoy Smith and Ray W. Fisher (Ames Lab., Ames, Iowa). Aug. 1963. Contract W-7405-eng-82. 49p.

The longitudinal temperature distribution is determined for a finite hollow cylindrical manometer column with heat sources at the lower end and along the axis of the column. A nonlinear relation for the heat loss from the Inconel column to the atmosphere was determined empirically and used in the theoretical calculation of the temperature distribution. The theoretical solution involved the solution of two sets of equations containing double infinite series. These equations were solved on the IBM 7074 computer. Experimental measurements of the temperature distribution along the column were made using chromel-alumel thermocouples spotwelded to the surface of the column. The experimental measurements were compared with the theoretical results to prove the validity of the theory. (auth)

37476 (AEC-tr-6398(p.232-45)) THE USE OF RADIOACTIVE ISOTOPES IN CERTAIN FIELDS OF CATHODE ELECTRONICS. G. N. Shuppe and V. P. Vasil'ev. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 182-?(1962).

The use of the labeled-atom method in the investigation of migration and diffusion of cathode substances, evaporation and cathode atomization of the parts of electrovacuum instruments, etc., is discussed. The method was used to study the oxide-type cathode, as well as other direct incandescence evaporation cathodes, and certain processes related to the preparation and service periods of radio tubes. The evaporation of tantalum (enriched in ^{182}Ta) and tungsten (enriched in ^{185}W) cathodes; the diffusion of Fe in Ni, W, Ta, and Ag; the diffusion of alkaline earth metals in Ni, Ag, and Au; and autoradiographic techniques in cathode investigation are discussed. (R.E.U.)

37477 (AEC-tr-6398(p.306-10)) USE OF NUCLEAR RESONANCE FOR THE MEASUREMENT AND STABILIZATION OF WEAK MAGNETIC FIELDS WITH CONSIDERABLE INHOMOGENEITY. A. I. Zhernovoĭ and G. D.

Latȳshev. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 236-?(1961).

Field inhomogeneity within the volume of pickups for nuclear resonance measurements in homogeneous fields is considered. It was found that for measurement and stabilization of weak inhomogeneous magnetic fields, a pickup in which the removal of saturation can be guaranteed without addition of paramagnetic ions is required, and a resonance signal of sufficient amplitude can be obtained in a weak field with a small working volume. (R.E.U.)

37478 (AEC-tr-6398(p.311-13)) MEASUREMENT OF DIRECT CURRENT USING NUCLEAR MAGNETIC RESONANCE ACCORDING TO THE NUTATION METHOD. A. I. Zhernovoĭ and G. D. Latȳshev. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 240-?(1961).

The procedures for determining a strong direct current from NMR measurements of the magnetic field created by the current, passing along a conductor-transformer, are discussed. A single nutation pickup is used, and the current dependence of the field can be obtained. (R.E.U.)

37479 (AEC-tr-6398(p.314-21)) DEPENDENCE OF THE FREQUENCY OF A NUCLEAR RESONANCE "MASER" ON THE PARAMETERS OF THE UNIT. A. I. Zhernovoi and G. D. Latȳshev. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 242-?(1961).

Equations are presented relating the dependence of the vibrations excited in an r-f circuit during radiation relaxation of polarized nuclei on the parameters of the circuit and the inhomogeneity of the magnetic field. Experimental verification for water using a nutation pickup is presented. (R.E.U.)

37480 (NASA-TT-F-141(p.22-47)) FLIGHT-TYPE MASS SPECTROMETERS. G. M. Martynkevich. (A translation).

A brief account of the development of flight-type mass analyzers, some of their specifications, the parameters of instruments used in rocket investigations, and some laboratory mass-spectrometers that appear promising for future use in rocket investigations are presented. 107 references. (auth)

37481 (NASA-TT-F-141(p.48-65)) THE OMEGATRON MASS SPECTROMETER. A. F. Chizhov. (A translation).

An outline of the theory of the omegatron mass spectrometer is given, and certain results of the development of a laboratory model of this instrument are presented. (auth)

37482 (NASA-TT-F-141(p.66-95)) SOME PROCESSES OCCURRING IN A MASS SPECTROMETER. A. I. Repnev and A. F. Chizhov. (A translation).

A survey of the physical processes that occur in a mass spectrometer affecting the results of measurements of the composition of a gas mixture is given. (auth)

37483 (NASA-TT-F-141(p.96-107)) CERTAIN PRELIMINARY RESULTS OF THE DEVELOPMENT OF A METHOD FOR THE QUANTITATIVE DETERMINATION OF THE COMPOSITION OF A GAS MIXTURE BY AN OMEGATRON MASS SPECTROMETER. A. F. Chizhov. (A translation).

A graduated vacuum apparatus is described, and results of investigations of some of its parts are presented. Results are given of an experiment for selecting a material for the cathode of an omegatron mass spectrometer, that does not affect measurements of the partial pressure of molecular nitrogen. (auth)

37484 (NASA-TT-F-141(p.108-18)) A SWEEP OSCILLATOR. A. S. Ozerova. (A translation).

A sweep oscillator of small dimensions for use in an omegatron mass spectrometer is described. (auth)

37485 (NASA-TT-F-141(p.119-22)) THE USE OF THE ELECTRONIC SYSTEM OF THE FEU-34 PHOTOMULTIPLIER AS AN AMPLIFIER OF WEAK ION CURRENTS. A. V. Fedynskii. (A translation).

It is shown that the electronic system of a photomultiplier can be used to amplify ion currents. (auth)

37486 (NASA-TT-F-141(p.123-31)) A VACUUM SYSTEM FOR MASS-SPECTROMETRIC ANALYSES OF THE ATMOSPHERE. O. K. Kostko and A. V. Fedynskii. (A translation).

A vacuum system is suggested to enable mass-spectrometric analyses to be carried out in the atmosphere at pressures above 10^{-4} mm Hg. (auth)

37487 (NASA-TT-F-141(p.132-42)) DENSITY MEASUREMENTS BY A TIME-OF-FLIGHT METHOD. Yu. A. Bragin. (A translation).

A method is suggested for measuring the density of a gas in the pressure range 10 to 10^{-3} mm Hg. Collision processes of ions with molecules can be investigated by this method. An instrument for density measurements in the pressure range 10 to 10^{-1} mm Hg is described. (auth)

37488 (NASA-TT-F-141(p.152-5)) MEASUREMENTS OF GAS DENSITY BY DETERMINING THE PATH LENGTH OF LITHIUM IONS. Yu. A. Bragin. (A translation).

A method of measuring air density at pressures from 10^{-1} to 10^{-3} mm Hg by determining the path length of lithium ions is described. (auth)

37489 SIMPLE PARTIAL PRESSURE GAUGE. L. Goldstone (Imperial Coll. of Science and Tech., London). Rev. Sci. Instr., 35: 1265-7(Oct. 1964).

A gauge based on the 180° mass spectrometer is described which is simple to make and to operate. It can be used to analyze the constituent gases in a vacuum system at partial pressures as low as 2×10^{-11} torr. Several of these instruments were tested and the sensitivity and resolution were constant to within 10%. The gauge has a resolution of about 50, which is adequate for separating the common residual gases in a high vacuum system, and it is small so that it can easily be outgassed. Constructional details are given, and its operating characteristics are discussed. (auth)

37490 DEMOUNTABLE MASS-FILTER CELL FOR USE IN HIGH VACUUM. Karl-Georg Guenther, Helmut Freller, and Gunther Titze (to Siemens-Schuckertwerke Aktiengesellschaft). U. S. Patent 3,143,647. Aug. 4, 1964. Priority date Mar. 7, 1961, Germany.

An electric mass filter apparatus is designed for use as a partial-pressure vacuum meter at low gas pressures $<10^{-4}$ mm Hg. The components of the analyzer portion (rod electrodes and inlet and outlet diaphragms) are mounted together to form a unit that can be adjusted independently of the other components of the apparatus. (D.L.C.)

37491 INFORMATION CODING AND SENSING BY MEANS OF BETA-RAY BACKSCATTERING. Thomas E. Mitchell, Orear Kenton Neville, and Ariel G. Schrodt (to

Nuclear-Chicago Corp.). U. S. Patent 3,143,649. Aug. 4, 1964. Filed Mar. 19, 1959.

A beta-scattering apparatus is designed for sensing the location of a postage stamp on envelopes so that they can be arranged in the same orientation. The stamp has a high-atomic-number material, such as lead sulfate, a white pigment on which the stamp inks can be printed. The beta source preferably is a promethium-147 source, and Geiger counters are used to detect the scattered beta particles. (D.L.C.)

37492 X-RAY COLLIMATOR COMPRISING A PLURALITY OF SPACED PLASTIC LAMINA WITH X-RAY ABSORBENT MATERIAL COATED THEREON. John E. Bigelow (to General Electric Co.). U. S. Patent 3,143,652. Aug. 4, 1964. Filed May 31, 1960.

An x-ray collimator comprising an array of Soller slits is designed in which the spaced planes have improved parallelism. The spaced planes are manufactured by covering thin sheets of plastic with a thin coating of lead, compressing together the sheets, and heating the compressed sheets so that they shrink. The resulting sheets have a high degree of parallelism and may be spaced apart by spacing bars. The sheets may also be used to make a capacitor or a microwave strip line. (D.L.C.)

37493 VACUUM ION GAUGE. Charles L. Giles (to Hughes Aircraft Co.). U. S. Patent 3,143,678. Aug. 4, 1964. Filed Dec. 5, 1961.

An ion gage is designed which has a linear ion current-vs-pressure characteristic and can be used at pressures less than 10^{-6} mm Hg. In this gage, the space between the anode and the cathode is kept constant, and the ratio of the width of the anode to the space between the plates should be at least 2:3 for good electron focusing. Several embodiments of the gage are described. (D.L.C.)

37494 METHOD FOR MAKING A COLLIMATOR FOR AN X-RAY BEAM. John E. Bigelow (to General Electric Co.). U. S. Patent 3,143,738. Aug. 4, 1964. Filed May 31, 1960.

A method is given for making an x-ray collimator of the Soller slit type. The method comprises the steps of depositing an x-ray absorbing film (e.g., lead) on thin laminas of a heat-shrinkable plastic, stacking and compressing the laminas, heating the stacked laminas to shrink them, and cooling the stack. (D.L.C.)

37495 CELL MEANS FOR SOFT X-RAY SOURCE. John Stanley Forrester and Francis Xavier Mayer (to Esso Research and Engineering Co.). U. S. Patent 3,144,559. Aug. 11, 1964. Filed Sept. 8, 1960.

A method is given for monitoring plant streams for their halogen, oxygen, or sulfur content, especially in Friedel-Crafts isomerizations, hydrofining, and butoxy production. The method is based on the absorption of soft x rays from iron-55. A cell block is designed which combines in one unit the radiation source, Be windows, Geiger counter, and passageway for the stream being monitored. (D.L.C.)

37496 SUPERCONDUCTIVE ELECTRIC SWITCH. Henry L. Laquer (to U. S. Atomic Energy Commission). U. S. Patent 3,145,284. Aug. 18, 1964.

A cryogenic electrical switch is described in which a superconducting wire passes through a non-superconducting metal container. The container is adapted to be immerged in coolant, and an open orifice in the bottom of the container and a gas duct connected to the top of the container are provided so that the wire is rendered superconducting when the container is filled with coolant and the wire is rendered non-superconducting when gas is injected into the container to remove the coolant. (AEC)

Radiation Detection

Refer also to abstracts 37088 and 37560.

37497 (A/CONF.28/P/85) THE DETECTION OF CRITICALITY ACCIDENTS IN THE COMMISSARIAT A L'ENERGIE ATOMIQUE. Guy Debrie, Jean Lavie, and Marc Planque. BURST CAN DETECTION. Roger Le Meur, Jean Megy, and André Roguin (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 17p.

The requirements on assemblies for detecting criticality accidents are summarized, together with the specifications adopted by the CEA for such equipment. The scintillator/photomultiplier probe, semiconductor detector probe, and data processing assembly developed at CEA are described. Systems developed for detection of fission products in reactor coolant are then discussed, including automation and measurement processing. Detection methods and systems used with specific reactors are described. (D.C.W.)

37498 (A/CONF.28/P/399) BURNUP DETERMINATION OF NUCLEAR FUEL BY HIGH-RESOLUTION GAMMA SPECTROSCOPY. M. J. Higatsberger, H. Hick, and P. Weinzierl (Osterreichische Studiengesellschaft fur Atomenergie G.M.B.H., Seibersdorf, Austria). May 1964. 12p.

The determination of burnup by measurement of ^{137}Cs and the 2.19-Mev line of ^{144}Pr is discussed, illustrating the need for high gamma energy resolution. A high-resolution gamma spectrometer is described, and practical results are reported. The spectrometer is based on the measurement of the Compton scattering events in a Li-drifted semiconductor detector. The principle of the Compton coincidence spectrometer is applied, providing a unique correspondence between the gamma energy and the observed peak in the pulse-height distribution. By using the high resolution properties of a semiconductor detector, a full width at half maximum of 18 kev, nearly independent of the primary gamma energy, is obtained. For the quantitative determination of ^{137}Cs, a minimum cooling time of two weeks is required. The spectrometer is very compact and requires at the location of the fuel element storage a collimator hole in the storage tank wall and a scanning machine for the fuel element itself. (auth)

37499 (A/CONF.28/P/416) A CRYSTAL DIFFRACTION SPECTROMETER FOR NON-DESTRUCTIVE BURN-UP ANALYSIS. J. Rohlin, S. Nilsson, B. Lundqvist, and R. Hardell (Chalmers Tekniska Högskola, Göteborg). May 1964. 15p.

A bent-crystal gamma spectrometer was built for burn-up measurements on reactor fuel elements. It will mainly be used adjusted to the Du Mond geometry. According to focusing properties a line-shaped source must then be used and consequently a very narrow part of the fuel element will be analyzed. The extension of the source is defined by slits in the radiation shield in front of the fuel element. The combined effect of slit geometry and gamma-ray self-absorption in the fuel element results in a suitable approximated line source. The spectrometer can easily be changed for use also in the reversed (Cauchois) geometry. In this case a larger part of the fuel element is studied, the size of which being mainly determined by the effective area of the diffraction crystal. In both cases a NaI-crystal is used as detector. The bending radius of the diffraction

crystal is four meters. Diffraction takes place against the (310)-planes in a 80 × 80 × 3 mm quartz crystal. The fuel element is placed in a radiation shield consisting of a transportable gas-sealed container, where it can be rotated and elevated in front of the source-defining slits. Consequently, a detailed analysis over the whole element surface is possible. Determination of the burnup is based on intensity measurements of diffraction peaks from fission product gamma lines. From measurements performed at the one-meter bent-crystal spectrometer the required gamma intensities of some selected fission products were estimated. Calculations show that the intensities from the chosen gamma lines are sufficient for obtaining diffraction peaks of reasonable statistics. (auth)

37500 (A/CONF.28/P/610) STUDY OF RELEASED ACTIVITY DISTRIBUTIONS WITH THERMOLUMINESCENCE DOSIMETERS. Bengt Bjaerngard (Aktiebolaget Atomenergi, Studsvik, Sweden). May 1964. 14p.

As a complement to other experimental methods for the study of the behavior of radioactivity released in free air or water, there is a need for a technique consisting of mapping the exposure distribution from a controlled discharge of for instance ^{41}Ar in air or ^{82}Br in water. From the radiation protection point of view, such work must be performed with the smallest possible amount of radioactivity. This implies that a type of dosimeter is required with which some tens of microroentgens can be measured, i.e., an exposure of the same order of magnitude as that caused by the natural background radiation during a few hours. The dosimeter should also be cheap and simple so that many measuring points can be used in an experiment. These requirements eliminate most types of dosimeters, but are fulfilled by a dosimeter developed on the basis of the thermoluminescent properties of $CaSO_4$: Mn. The thermoluminescence of this phosphor shows a high sensitivity to ionizing radiation. Its limited thermal stability does not cause any serious difficulties in controlled experiments. The dosimeters are constructed for measurements of exposures of gamma radiation only, and under laboratory conditions the reproducibility at 50 microroentgens is better than ±20% (standard deviation). In field experiments, the exposure to natural background radiation impairs the precision somewhat. The feasibility of mapping exposure distributions with these dosimeters has been studied in some experiments. ^{41}Ar was released in free air near the ground, and the exposures were measured in a vertical plane about 100 meters from the release point. Practical experience was satisfactory. This is also true for experiments in water with ^{82}Br. These experiments are described. In many release problems, the concentration is the required quantity rather than the exposure. In air, the interpretation of the results in terms of concentration is complicated by the fact that activity at large distances from the measuring point contributes significantly to the exposure. This problem has been studied with numerical calculations. The spatial resolution is sufficient for most practical problems. This is also the case in water, where the photons have a short practical range. The technique described is best suited for experiments on a relatively small scale, where the distance between release point and measuring point is less than say 200 meters. It has the advantage of providing a large number of measuring points in fixed positions. In many cases it can be used where other methods, including calculations, are questionable or impossible, as for instance in or near buildings and in vegetation. In this way, the technique can be a valuable complement to established methods for the study of the behavior of radioactivity released in air or water. (auth)

37501 (A/CONF.28/P/616) THE CHEMICAL DOSIMETRY OF IONIZING RADIATIONS. A. M. Kabakchi, Ya. I. Lavrentovich, and V. V. Penkovskii (U.S.S.R.). May 1964. 9p.

The possibilities and principal features of chemical dosimetry are considered. (T.R.H.)

37502 (A/CONF.28/P/791) DESIGN OF AN ELECTROSTATIC PRECIPITATOR MONITORING SYSTEM FOR RUPTURED FUEL ELEMENT DETECTION. B. S. Prabhakar, R. Sethuraman, K. Srinivasan, and K. Venkatachalam (India. Atomic Energy Establishment, Trombay). May 1964. 18p.

The performance of an "Electrostatic Precipitator Monitor" for the detection of ruptured fuel elements was studied, simulating the conditions of rupture at Apsara Reactor with air and CO_2 as carrier gases. Optimization of parameters is indicated and design methods are discussed. Calculations were performed to determine the efficiency of the system taking into consideration the relevant fission product chains. Agreement between theoretical and experimental results is shown. The design was modified for water carrier system using air as scrubber gas. A monitor based on this design is being installed at Apsara Reactor. (auth)

37503 (A/CONF.28/P/815) MEASUREMENT OF HIGH-DOSE GAMMA FLUXES AT REACTOR PULSES AND STRONG GAMMA SOURCES BY THE CONDUCTIVITY OF CUPROUS OXIDE. O. Bobleter and P. Vajda (Österreichische Hochschule, Vienna. Atominstitut). May 1964. 15p.

Cuprous oxide with a coarse crystalline structure was produced from copper plates (1 × 20 × 80 mm) by a special oxidation process. The specific electric conductivity of this material is not different from that of single crystals. In the case of fine crystalline specimens, the conductivity increases proportionately with the number of crystals per unit area. This behavior is the result of higher concentration of crystal defects on the grain surfaces. Under the influence of gamma and x-ray irradiation the conductivity is increased; the lower the initial conductivity of the material, the greater is the relative effect. The results thus obtained showed a linear dependence and proved coarse crystalline Cu_2O to be most suitable for high gamma flux determinations. (auth)

37504 (A/CONF.28/P/855) GAS PHASE METHODS OPERATING AT ATMOSPHERIC PRESSURE FOR THE ANALYSIS OF SOFT β-EMITTING ISOTOPES. S. Mlinko (Magyar Tudomanyos Akademia Kozponti Kemiai Kutato Intezete, Budapest) and T. Szarvas. May 1964. 16p.

For the measurement of radioactivity of organic compounds labeled with soft β-emitting isotopes (^{3}H, ^{14}C, and ^{35}S), gas counting and/or liquid scintillation methods are employed at present. The most exact analysis can be carried out in proportional region with the aid of an internal gas counter. However, filling of such counters requires cumbersome and expensive vacuum systems being. An effort was made to eliminate the difficulties accompanying the traditional analysis of radionuclides of labeled organic compounds by elaborating simple new methods operating exclusively at atmospheric pressure instead of using vacuum lines. This could be achieved by adapting suitably constructed counter systems to the classical combusting methods of organic microchemical analysis. Results are given for $^{14}CH_4$, $^{14}CO_2$, $C_2{}^{3}H_6$, and $H_2{}^{35}S$. (auth)

37505 (AD-600297) DEVELOPMENT ENGINEERING OF CD V-797 CALIBRATOR. Final Report. (Nuclear-Chicago Corp., Des Plaines, Ill.). Apr. 1964. Contract OCD-OS-62-197. 35p.

A research and development program was conducted to design and produce the OCD Item No. CD V-797 Calibrator, which was to be used for field radiation calibration and range checking of the OCD Item No. CD V-711 Remote Sensor Radiation Meter. Each calibrator comprised a small source with an electrometer and high voltage test circuit. Two prototype models of the calibrator were constructed, and each was used to standardize three CD V-711 remote sensors. Comparisons were made with R-meter calibrations, and estimates were derived for over-all accuracy and precision. Measurements were also made to assure conformance to AEC and ICC specific device requirements. The report contains laboratory test data, assembly and schematic drawings, production cost estimates, and parts lists. (auth)

37506 (AERE-R-4643) A NEUTRON DIFFRACTION ASSEMBLY AT PLUTO. K. A. D. Lambe (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). July 1964. 17p.

A description is given of an assembly at PLUTO that will accommodate up to four single-crystal diffractometers carrying out separate experiments at the same time. The monochromators work at a Bragg angle of $22\frac{1}{2}°$, 45°, and $67\frac{1}{2}°$. Measurements are given of the monochromatic neutron flux and of the background, due to fast neutron and gamma radiation with different combinations of out-of-pile shielding. (auth)

37507 (AWRE-NR-2/64) THE USE OF A GAS-FILLED SPHERICAL PROPORTIONAL COUNTER FOR NEUTRON SPECTRUM MEASUREMENTS IN A ZERO ENERGY FAST REACTOR. P. W. Benjamin, C. D. Kemshall, and J. Redfearn (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). July 1964. 21p.

Hydrogen-filled proportional counters were used to measure the neutron spectrum in the core of the fast reactor VERA over the energy range 30 to 400 kev. Theoretical studies were made of the distortion of the recoil proton spectrum caused by counter wall effects, and a method of analyzing the experimental spectra that corrects for these distortions is described. Measurements of the spectrum in core 7A of VERA are described and results are compared with theoretical calculations. (auth)

37508 (BNL-874(p.19-20)) A GAMMA-RAY MONOCHROMATOR. M. S. Zucker (Brookhaven National Lab., Upton, N. Y.).

Construction of an instrument that makes use of Compton scattering of gamma rays from a radionuclide to produce a variable energy high resolution source of gamma rays is described. The instrument consists of a radionuclide source in a collimating pig, a scatterer, and another collimating pig containing a target or detector, all located on the circumference of the same circle. The scatterer is in the form of a plate of metal rolled to have the same radius of curvature as the circle. The intensity will be about 10^3 photons per second at the target position for Curie in the source. The instrument has several uses ranging from pure to applied physics, chemistry, and biology. (P.C.H.)

37509 (BNL-874(p.21)) CALORIMETRIC DETERMINATION OF TOTAL CURIE CONTENT AND SELF-ABSORPTION IN KILOCURIE SOURCES. Francis X. Rizzo (Brookhaven National Lab., Upton, N. Y.).

An adiabatic calorimeter that employs a large block of depleted uranium in which a known fraction of the radiation energy from a gamma source is absorbed was designed and constructed. Knowledge of the total mass and heat capacity of the uranium block and the source, coupled with measurements of the rate of temperature rise of the block and source, resulted in direct accurate determinations of both total Curie content and self absorption. The system is capable of handling sources up to six inches in length and $\frac{3}{4}$ in. in diameter with total activities as low as 100 C. A second calorimeter was designed employing a high-density W alloy block that is capable of handling sources up to 13 in. in length and 1.5 in. in diameter with total activities above 1000 C. (P.C.H.)

37510 (BRL-Memo-1545) THE USE OF THE He^3 SPECTROMETER IN NEUTRON ATTENUATION MEASUREMENTS. A. Manning, T. Jeter, H. Schuckler, and W. Slack (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Feb. 1964. 9p. (AD-600057)

The ^{3}He sandwich-type spectrometer has proved to be an extremely good detector for making neutron spectra and attenuation measurements. A method of procedure is outlined to demonstrate how neutron relaxation lengths can be measured easily, and how this technique can be applied to other neutron measurement problems. (auth)

37511 (NP-14116) RECHERCHES SUR LES CARACTERISTIQUES ET LE MECANISME DES COMPTEURS A ETINCELLES A FILS OU A SPHERES ANODIQUES (thèse). (Investigations on the Characteristics and the Mechanism of Spark Counters with Wire or Spherical Anodes (thesis)). Paul Laborie (Toulouse, France. Université). [1962]. 121p.

The role of the corona discharge and its effect on the voltage actually applied to the electrode terminals was studied. A prototype of very general character was constructed so that the characteristics of any counter could be deduced. It was verified that the stability was bound to the presence of corona discharge and that a counter with spherical anodes had characteristics very similar to those of a wire-anode counter. The effect of the voltage on the sensitivity of the detector was measured as a function of the orientation of the incident particle trajectory, and the sensitive volume of a prototype counter was explored. The influence of the orientation of the incident particle trajectory with respect to the lines of force of the electric field was shown. The efficiency of the device and the slope of the counting characteristics had a linear relation with the distance separating the electrodes. The properties of the electric circuit were studied in detail, and the discharge mechanism was defined. (J.S.R.)

37512 (NP-14130) CONTRIBUTION À L'ÉTUDE DU FONCTIONNEMENT, À LA TEMPÉRATURE AMBIANTE, DE CHAMBRES D'IONISATION REMPLIES D'HEXANE LIQUIDE. LEUR APPLICATION À LA MESURE DE FLUX DE NEUTRONS RAPIDES (theses). (Contribution to the Study of Operation, at Room Temperatures, of Liquid Hexane-Filled Ionization Chambers. Their Application to Measurement of Fast Neutron Flux (thesis)). Paul Vermande (Toulouse, France. Université). May 21, 1963. 79p.

The possibilities for the use of an ionization chamber filled with hexane for gamma rays and fast neutrons are defined. Contamination of the filling gas by contact with the walls was avoided by enclosing the liquid in an envelope of

polyethylene. The chamber operation was thus stabilized. In the region of the plateau, the sensitivity, defined by the ratio R = current under irradiation/background, was independent of the applied field. The sensitivity values for ^{60}Co γ rays and 14.7- and 3-Mev neutrons were determined. (J.S.R.)

37513 (NP-14166) SUR LA RÉALISATION, PAR BROMURATION D'UN HYDROSOL D'ARGENT, DE NOUVELLES ÉMULSIONS NUCLÉAIRES DE PLUS HAUTE SENSIBILITÉ (theses). (On the Development, by Bromination of a Silver Hydrosol, of New Nuclear Emulsions of High Sensitivity (thesis)). Jean-Claude Fayolle (Paris. Université). 1962. 24p.

The chemical effects capable of changing the sensitivity and clouding of nuclear emulsions were investigated in order to obtain the maximum sensitivity with the minimum density of clouding grains. The nuclear emulsions obtained by bromination of a silver hydrosol dispersed in gelatin had great advantages. The grains obtained, numerous and very fine, gave a better discrimination of the tracks, and the precision of the measurements was improved. New techniques of bromination, sensitization, and development at controlled pH gave a high sensitivity with respect to the crystal dimensions. The clouding density was also significantly reduced. The minimum energy necessary to make a crystal developable was calculated as 400 ev. (J.S.R.)

37514 (NP-14189) ANALYSE D'UN "UNIADDITIONNEUR" POUR ANALYSEURS MULTICANAUX RAPIDES (theses). (Analysis of a "Uniadditionneur" for Fast Multichannel Analyzers (thesis)). Louis Frecon (Lyon. Universite). June 30, 1964. 102p.

A "uniadditionneur" integrated in a fast multichannel analyzer of 100 channels at 500 nsec was constructed. After a consideration of the length of the memory cycle, a maximum time for the addition of 150 nsec was allocated for the realization of the following program: preparation of flip-flops and gating according to the contents of the address chosen by the memory; and the addition of 1, all reports made, the number having 5 digits and the treatment being made in decimals. The final time was thus 170 nsec if the counting began with the beginning of the brief read-out order, sufficient for the transistorized memory, or 130 nsec from the end of this order, which has the role of simulating the pulse from the memory read-out amplifiers. In order to obtain these characteristics, a series of solutions were reviewed by examining the delay introduced by each and the complexity of the circuits. A compromise was made between rapidity and simplicity. A bistable base circuit was then made up. A programmer and a recorder used as memory were also constructed. With these correct sequences could be observed and the time necessary for the realization of the program could be measured. (tr-auth)

37515 (ORNL-TM-931) STUDIES OF THE DOSIMETRY OF HIGH-ENERGY RADIATION. Progress Report, July 1, 1963–June 30, 1964. J. E. Turner, Jacob Neufeld, H. A. Wright, and W. S. Snyder (Oak Ridge National Lab., Tenn.). Aug. 26, 1964. Contract W-7405-eng-26. 32p.

Progress is reported in studies relevant to dosimetry for high-energy radiation. The dose calculations for protons with energies up to 400 Mev were essentially completed. The response of an array of silicon detectors was studied, and a conceptual design of a high-energy proton dosimeter was made. The computer codes for estimation of the distribution of dose with LET due to irradiation by neutrons of energies up to 14 Mev were completed by the inclusion of the dose due to capture photons. These distributions of dose over the range of LET values as obtained for phantoms typical of experimental animals and for man were studied to determine the relationship of RBE and LET, using typical biological data of the effects of neutron and gamma radiation on mammals. (C.H.)

37516 (SRB-63-7) NEUTRON FLUX MEASUREMENTS: AN ANNOTATED BIBLIOGRAPHY. Charlie M. Pierce, comp. (Lockheed Missiles and Space Co., Sunnyvale, Calif.). Sept. 1963. 61p. (AD-600707)

The references cited deal with all aspects of neutron flux measurements. Most of the references were published between June 1959 and June 1963. The references are alphabetically arranged according to the first author. Corporate and personal author indexes are included. (auth)

37517 (UCRL-11425) OPERATION OF THE SMP DATA-ANALYSIS SYSTEM. William E. Humphrey and Ronald R. Ross (California. Univ., Berkeley and California. Univ., Berkeley. Lawrence Radiation Lab.). June 22, 1964. Contract W-7405-eng-48. 18p. (CONF-550-12)

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

Scanning and Measuring Projectors (SMP's) were used to measure 72-inch hydrogen bubble-chamber film from the "K-63" and "π-63" exposures since August 1963. As of May 1, 1964, approximately 40,000 measurements of events of all types have been done on SMP's. Evaluation of the SMP system for the measurement of these events is presented. The accuracy of measurement, rate of rejection of events, rate of measurement, and total system capabilities are discussed. (auth)

37518 (USAELRDL-TR-2334) NOISE SIGNALS AND CARRIER MODULATION ARISING IN ELECTRICAL CABLES DURING NUCLEAR PULSE IRRADIATION. Eberhard Both, Horst P. Bruemmer, Charles P. Lascaro, Joseph Newberg, and William Schlosser (Army Electronics Research and Development Lab., Fort Monmouth, N. J.). Mar. 1963. 40p. (AD-406623)

The electrical noise signals generated in the individual conductors of coaxial and other cables by incident nuclear radiation pulses were studied as a function of the applied voltage and the exposure history. Training processes were found to reduce the response signals in repetitive exposures, while storage or memory effects can cause strong readout signals if the applied voltage is changed in successive shots. Oscillatory signals in the center conductor were found to be caused by differentiation of the unexpectedly large shield current pulses. The latter can also inject parasitic leakage currents into other conductors nearby. An r-f signal transmitted through RG62 A/U cable suffers a temporary attenuation of almost 20 per cent, while it passes through RG59 B/U cable unaffected. Methods for the dynamic measurements of noise, resistance, attenuation, and impedance are described, and definite rules are given for minimizing noise signals from cables used in nuclear pulse radiation measurements. (auth)

37519 (AEC-tr-6398(p.296-305)) RESOLVING POWER OF THE SCINTILLATION SPECTROMETER. G. S. Dombrovskaya, D. K. Kaipov, and Yu. K. Shubnyĭ. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 229-?(1961).

The effects of individual processes in the gamma detector and spectrometer operation on the energy resolution are discussed. A procedure is described, based on electron beam modulation in the photomultiplier, that permits determination of the amplitude resolution of the photomulti-

plier. Optimization of crystal thickness is considered. (R.E.U.)

37520 (AEC-tr-6398(p.355-61)) SENSITIVITY OF SILICON PHOTOCELLS TO GAMMA RAYS. A. Shalpȳkov and E. M. Lobanov. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 271-?(1961).

The preparation and properties of silicon valve photocells are discussed. Experimental responses of the cells were obtained for light, gamma, and x rays. (R.E.U.)

37521 THE DARKENING OF AGFA-SCHUMANN AND Q_2 PLATES BY IONS OF DIFFERENT MASSES AND 2.5- TO 20-kev ENERGY. H. Wagner (Universität, Jena, Ger.). Ann. Physik (7), 13: 189-207(June 1964). (In German)

The darkening of Schumann and Q plates by ions of H, N, Ne, Kr, Xe, and Hg at 2.5 to 20 kev was studied. (R.E.U.)

37522 THE PERFORMANCE OF A GEIGER-MUELLER COUNTER IN THE 100-300 Å REGION. D. L. Ederer and D. H. Tomboulian (Cornell Univ., Ithaca, N. Y.). Appl. Opt., 3: 1073-8(Sept. 1964).

The construction and the performance of a GM counter designed specially for the measurement of low-energy (40–120 ev) photon fluxes are described. The successful operation is determined by the strength and transmissivity of the counter window as well as the cross section of the counting gas. Various tests with different radiations and counting gases indicate that the counter behaves in a predictable way and that the primary cause of a count is the production of an ion pair arising from the absorption of a soft x-ray photon. Because the discharge of the counter corresponds to the stopping of a single photon the counter may serve as a detector of absolute photon fluxes of soft radiation. (auth)

37523 IMPORTANCE OF THERMAL EQUILIBRIUM IN THERMOLUMINESCENCE MEASUREMENTS. J. G. Carter, R. D. Birkhoff, and D. R. Nelson (Oak Ridge National Lab., Tenn.). Health Phys., 10: 539-42(Aug. 1964).

Measurements of intensities, spectra, and yields of thermoluminescence from irradiated biological materials such as the aromatic amino-acids are complicated by difficulties in obtaining a suitable sample environment. A sample holder should be tissue equivalent for dose measurements, non-fluorescing and non-thermoluminescing, electrically and thermally conducting, structurally strong over a wide range of temperature, and capable of holding a high vacuum. After evaluating many materials with regard to the above requirements, a holder was designed and fabricated from boron carbide. Dose measurements in the holder using Fricke dosimeters and Victoreen r-meters indicated agreement with air dose values. All other requirements were satisfied by this holder. Thermoluminescence measurements, conducted in vacua ranging from 10^{-6} to 50 torr, showed light intensity depended not on the type but on the pressure of the gas. Sample temperature studies revealed that the sole function of the gas was to produce temperature equilibrium between the sample and the bottom of the sample holder, although the sample was almost completely surrounded by walls at the sample holder temperature. Study of the radiative heat transfer in the system explains this result and points to a possible source of error in thermoluminescent dosimetry. (auth)

37524 A NEW INSTRUMENT FOR CONTROLLING LOW-ENERGY RADIATIONS. Gabriel Dupuy. Ind. At., 8: Nos. 5-6, 89-91(1964). (In French)

A portable instrument for the detection and measurement of low-energy x and gamma rays was developed. The detector is an ionization chamber with a thin mylar window. High sensitivity and stability were obtained by using a vibrating armature and a transistorized electrometric circuit. The spectral response is ±10% from 30 kev to 1.3 Mev with an Al cap covering the window and ±15% from 6.5 kev to 1.3 Mev with the cap removed. A block diagram is given of the instrument, and the control characteristics are tabulated. (J.S.R.)

37525 NOTE ON THE ABSOLUTE DETECTION EFFICIENCY OF A CYLINDRICAL SCINTILLATION γ-RAY DETECTOR. C. C. Grosjean (Rijksuniversiteit, Ghent). Intern. J. Appl. Radiation Isotopes, 15: 239-40(Apr. 1964).

Practical formulas developed for determining the absolute detection efficiency of a cylindrical scintillation gamma-ray detector are given. (P.C.H.)

37526 THE BETA SELF-SHIELDING CORRECTION FOR 2π GEOMETRIES. G. R. Dalton and H. H. Kunaish (Univ. of Florida, Gainesville). Intern. J. Appl. Radiation Isotopes, 15: 301-7(May 1964).

A new method was developed for correcting β-count rates for absorption of β-particles in volume sources counted in 2π proportional counters. It assumes that β-absorption follows an exponential law along any flight path. The integration over all possible angles of β-penetrations through a thin foil is carried out analytically. The theory predicts that the β-transmission through a plane cover layer should vary as an exponential integral of the second kind ($E_2(\bar{\mu}x)$) as a function of cover thickness, x. With volume sources the transmission is shown analytically to be governed by the E_3 function. Experimental measurements show excellent agreement with the theory and provide a demonstration of a simple, new way of determining experimentally the β-self-absorption correction for cover layers or for volume sources. (auth)

37527 EXPERIENCE WITH THE OAK RIDGE AUTOMATIC THREE-CIRCLE NEUTRON DIFFRACTOMETER. W. R. Busing, H. G. Smith, S. W. Peterson, and H. A. Levy (Oak Ridge National Lab., Tenn.). J. Phys., 25: 495-6 (May 1964).

The automatic three-circle neutron diffractometer is a punched paper tape controlled device with paper tape output. It has been in operation since June 1961 and is capable of measuring the intensities of 120 single-crystal reflections per day. The instrument and computer programs associated with it are described briefly. Methods of crystal orientation are discussed, and some of the difficulties encountered are mentioned. (auth)

37528 THE USE OF NUCLEAR EMULSION A-2 FOR MONITORING THE RADIOACTIVITY OF THE ATMOSPHERE. V. Matuleviciene and V. Matulevicius (State Univ., Vilnus, USSR). Lietuvos TSR Aukstuju Mokyklu Moksto Darbai, Geogr. ir Geol., 2: 119-25(1962). (In Russian)

The use of type 2A, 50-μ nuclear emulsion in monitoring radioactivity was tested using 0.02- to 0.25-mm copper, brass, and tin foils used for wrapping bakery goods and tobacco products. It was found that a 1 cm^2 surface of brass foil emits 1.8, tin foil 1.6, and copper foil 2.6 α particles per day. A simple graphic method is suggested for measuring α tracks in the emulsion. The effects of an air layer between the source and the emulsion surface were also analyzed. An air thickness of 0.1 to 0.21 mm does not effect the track lengths, however, a thickness >0.21 mm reduced the number of nearly horizontal tracks. (R.V.J.)

37529 PROPORTIONAL COUNTERS MADE OF GLASS FOR DETECTING THERMAL NEUTRONS. M. Draghicescu, B. Ianculovici, T. Ivanov, and D. Todireanu. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 207-13(1961). (In Russian)

A glass counter possessing a graphite cathode and filled with BF_3 was investigated. The measurements carried out at the reactor of the Institute of Atomic Physics and with a 10^6 n/cm^2·sec Po–Be source indicated that the specially prepared MgO-containing glass possesses a transparency higher than 98%, thus being equal to stainless steel and other metals used for the construction of neutron sources. The BF_3 gas used was enriched in the ^{10}B isotope. A 0.05-mm diameter W wire served as the anode of the counter while graphite deposited on the inner surface of the MgO glass was used as the cathode; the resistance between the electrodes was more than 10^{12} ohm. Before filling with BF_3 gas, the system was outgassed at a pressure less than 10^{-4} mm of Hg. The completed counter was tested, determining the dependence of the count rate on the applied pressure with and without the neutron source and repeating the tests after 12 months of operation. The pulse height distribution of new and used counters was measured in a similar way. It was found that the plateau of the count rate vs. voltage curve extends from 300 to 500 v with a slope of less than 2% per 100 v, at a count rate of less than 10^5 pulses/sec. The counter exhibited excellent stability after one year of operation. It is concluded that the proposed design and method of fabrication yields a satisfactory counter. (TTT)

37530 CALCULATION OF THE EFFICIENCY OF CYLINDRICAL COUNTERS PLACED IN A THERMAL-NEUTRON BEAM. M. Vorisek (Inst. of Nuclear Investigations, Prague). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 215-28(1961). (In Russian)

The overall neutron-counting efficiency of the cylindrical, gas-filled counters such as proportional counters, BF_3 chambers, and detectors with solid deposits, which are often employed for neutron counting, is usually determined on the basis of the number of absorbed neutrons and of the losses incurred during the counting of the charged particles formed by neutron capture. The absorption of the thermal and resonance neutron beams was calculated assuming that the scattering is negligibly small with respect to the absorption. Attempts were made to determine separately the thermal-neutron absorption in the cylinder itself and in the layer deposited on it; in addition, formulas were derived for calculating the absorption in various portions of the cylinder. (TTT)

37531 SMALL FISSION CHAMBERS. A. Filip, I. Girlea, and V. Papureanu (Inst. for Atomic Physics, Budapest). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 229-38(1961). (In Russian)

Fission chambers used for the measurement of the spatial distribution of the neutron fluxes must possess a high sensitivity and excellent discrimination with respect to γ-radiation, without disturbing the neutron flux when inserted into the reactor. A relatively high sensitivity in a small volume may be achieved by choosing an element such as ^{235}U with a high macroscopic cross section and low radioactivity constant and by increasing the thickness of the fissioning layer. This problem was investigated by reviewing the features of plane-parallel, cylindrical chambers built at the Institute for Atomic Physics. The external electrode of the chambers was chosen to be not too small in comparison with the free path of the fission fragments in the gas at the usual operational pressures. The calculations indicated that the distribution of the trajectories of the particles emitted by the layer with the thickness t is similar to that of particles emitted by an infinitely thin layer placed in the median plane of layer t. A large and a small chamber were built, using stainless steel and Al_2O_3, heated to 1400°C, as structural materials. Natural U and ^{235}U, precipitated electrically, at a thickness of about 1 mg were used for both chambers, which were filled with technical Ar. The pressure was varied until the optimum discrimination was reached; this was based on a satisfactorily good peak of the differential discrimination and a long plateau with a slight slope of the integral discrimination curves. The dynamic range covered 5 decades with an integration time constant of $0.3 \cdot 10^{-7}$ sec. The chambers with relatively high pressures (3 to 4 atmospheres) had a relatively low sensitivity toward radiation. (TTT)

37532 CORRECTION FACTORS FOR THICK GOLD AND SULFUR PROBES. D. Albert and K. Faehrmann (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 239-45 (1961). (In German)

For experimental determination of the correction factor Q for thick foils of thickness d, the following relation is used: $Q(d) = S_\infty (d)/S_\infty (0)_1$ where S_∞ is the absolute specific saturation activity. The Q factors were determined for thermal and epithermal activation of gold foils and fast activation of cadmium-covered sulfur foils. (T.R.H.)

37533 A DEVICE FOR THE AUTOMATIC RECORDING OF THE ACTIVITY OF WIRES ACTIVATED IN THE REACTOR. V. Khristov, K. Sakalyan, and N. Bochvarov. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 247-53(1961). (In Russian)

Determination of the activity of wires or foils by the counting method presents several drawbacks, such as the long time period required for the measurement and the potential exposure of the experimenter to radiation. An automatic device was therefore worked out, allowing to record directly the exact activity of the wire. It included an about 1-m long framework which supported the wire, and a small electric motor moving the whole system, a reduction gear allowed to change the speed from 0.5 to 4 mm/sec. The instrumentation included a scintillation counter, a pulse amplifier, an intensity meter and a recording device. The measured portion of the wire was 7.5 cm from the NaI(Tl) crystal; use of a suitable Pb shield made it possible to keep the error due γ-radiation from neighboring portions below 1%. The device was tested in the core of the IRT-2000 reactor at Sofia by measuring the activity of Cu wires which were irradiated for 10 minutes while the reactor was operated at 10 kw. Two hours after removal the count rate at the 1-cm wide slit was somewhat above 1000 pulses/sec. By moving the wire at a speed of 2 mm/sec, the recording of one wire could be completed in 6 minutes; 4 specimens could be measured in 40 minutes, including installation and removal. The device was found to operate reliably and with satisfactory accuracy. (TTT)

37534 SOME RESULTS OF A STUDY OF THE OPERATION OF CORONA COUNTERS AND THEIR USE IN REACTOR MEASUREMENTS. V. Khristov, D. Damyanov, and N. Bochvarov. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 649-56(1961). (In Russian)

A study of the working characteristics of corona counters having different electrode geometries in argon showed that it is possible to obtain a stable corona in each case, and a

good counting plateau by proper selection of the loading resistance and argon pressure. A large cylindrical Al counter with a boron coating had an internal diameter of 40 mm and an effective length of 300 mm, and was an effective counter for neutrons of all energies. All the counters were thoroughly outgassed for 4 hours at 350°C and sealed in glass with argon to ensure stable operation. A high gamma background of 40 r/hr does not have any effect on the relative counting rate for neutrons of all energies. The counter operates with an amplification coefficient of 100 to 200 at ordinary stabilization of the high-voltage supply. A count rate of 2 neutrons/cm^2 · sec was measured through the concrete shielding of a reactor. The counting efficiency was 0.057%. (TTT)

37535 LARGE VOLUME SCINTILLATION CHAMBER FOR RADON COUNTING. Hobart W. Kraner, Gerald L. Schroeder, Anthony R. Lewis, and Robley D. Evans (Massachusetts Inst. of Tech., Cambridge). Rev. Sci. Instr., 35: 1259-65(Oct. 1964).

A 450-cc cylindrical Lucite chamber covered internally with ZnS(Ag) and viewed at each end by 5-in. photomultiplier tubes with summed outputs was used routinely as a low background (~ 0.8 counts per min for a new chamber) Rn scintillation counter. The counter is simple to construct and has operated reliably for about two years. The counting efficiency for Rn in transient equilibrium with its two alpha-emitting daughters is 2.1 counts per Rn decay. Thin lines of silver conducting paint applied externally on the ends of the chamber, together with surrounding Al foil, form a complete electrostatic shield which has assured reproducible counting efficiencies by suppressing randomly occurring internal fields. Results of experiments, in which external potentials were applied to the end plate electrodes of an experimental chamber, are presented in detail. It was found that as little as 22 v applied across the chamber can change the counting efficiency by 8%. A back voltage effect caused by the deposition of ionization-induced charge on the internal surfaces during voltage application was observed. (auth)

37536 MATERIAL FOR MAKING RESILIENT LIGHT PIPES TO BE MOUNTED WITHOUT SILICON GREASE. A. Strub (Euratom CCR, Ispra, Italy). Rev. Sci. Instr., 35: 1268-9(Oct. 1964).

For a special neutron scintillation counter a light pipe material was required which could replace Plexiglas or Lucite. This material had to be elastic in order to make a good fit between a scintillation crystal and photomultiplier even when mechanical dimensions (distance, parallelism) were somewhat undefined. Furthermore, the use of silicon grease for making an optical seal was to be avoided. Silicoloid 201, an embedding compound for electronic components and circuits, fulfills these requirements. It has a refractive index of 1.408 and a reasonable transmission for scintillation light wavelengths. In addition, it is easy to mold into any shape, and it adheres well to glass, forming stable but removable seals without grease. (auth)

37537 X-RAY SPECTROPHOTOMETER FOR SIMULTANEOUS ANALYSIS OF SEVERAL ELEMENTS. Bertil Jacobson and Bjoern Lindberg (Karolinska Institutet, Stockholm). Rev. Sci. Instr., 35: 1316-19(Oct. 1964).

A multichannel recording x-ray spectrophotometer was developed for quantitative analysis of macroscopic objects, such as liquid or solid specimens or the human body. The equipment comprises a special x-ray tube for generating monochromatic radiation by secondary emission, a system composed of servo-controlled absorption wedges, a scintillator photomultiplier unit for sensing the x-ray intensities of the radiation that has transversed the object and the wedges, and electronic feedback loops from the photomultiplier to the servo motors controlling the wedges. A set of stationary wedges and a photomultiplier are included to eliminate fluctuations in the x-ray intensities. The wedges are composed of, or contain, the elements being analyzed. The servo-controlled wedges are automatically kept in such a position that the intensities of the monochromatic x rays are constant at the scintillator photomultiplier. When the object is placed in the beam the wedges are automatically withdrawn a certain distance, the displacements constituting a quantitative measure of the amounts of the analyzed substances in the transversed volume of the object. Nondestructive quantitative analysis of unprepared specimens takes a few seconds. (auth)

37538 SPARK-GAP TRIGGER SYSTEM. G. Schrank (Univ. of California, Berkeley), G. Henry, Q. A. Kerns, and R. A. Swanson. Rev. Sci. Instr., 35: 1326-31(Oct. 1964). (UCRL-10903)

The construction and operation of a trigger system designed to fire a 30-kv 5000-A spark gap with a minimum of delay following the arrival of a small signal pulse is described. In the particular experiment for which the system was designed and used a 150-Mev/c muon is detected with scintillators on three 6199 phototubes, and the output pulse of the attached tunnel-diode triple-coincidence circuit is amplified and used to trigger the gap, which switches a current pulse through an inductive load. Approximately 32 nsec are needed from passage of the muon to the coincidence output, and approximately 25 nsec are required from the coincidence output to the time of complete breakdown of the gap. These delays represent the shortest times that could be achieved with the particular boundary conditions under which the circuit had to operate, i.e., these delays include all cables, light pipes, etc., in the working apparatus. Sufficient detail is given to show how additional savings of nanoseconds could be made under different operating conditions. (auth)

37539 SILICON PHOTODIODE VACUUM ULTRAVIOLET DETECTOR. A. J. Tuzzolino (Univ. of Chicago). Rev. Sci. Instr., 35: 1332-5(Oct. 1964).

The photosensitivity of silicon surface-barrier photodiodes was measured over the photon energy range from 4.9 to 21.2 ev (2537 to 584 Å). The photodiodes are operated in the reverse-bias mode at room temperature. The sensitivity of a typical photodiode with approximately 100 Å of gold on the sensitive surface is 0.16 electron per photon at 2537 Å and 1.1 electrons per photon at 584 Å. Photosensitivity did not vary more than a few percent over the sensitive area. The operating characteristics of these devices are reported, and the use of the silicon photodiode directly, or in combination with sodium salicylate, as a vacuum ultraviolet detector is discussed. (auth)

37540 INEXPENSIVE AUTOMATIC RECORDING MÖSSBAUER SPECTROMETER. J. Lipkin, B. Schechter, S. Shtrikman, and D. Treves (Weizmann Inst. of Science, Rehovoth, Israel). Rev. Sci. Instr., 35: 1336-9(Oct. 1964).

An automatic recording constant velocity Mössbauer spectrometer for ^{57}Fe is described. The motor and the velocity sensor are integrated in a specially designed electromechanical unit. Feedback is used to make the velocity proportional to an input voltage. Recorded linewidths only 25% larger than the natural width are obtained. (auth)

37541 PHOTOMULTIPLIER GATING SYSTEM. K. B. Keller and B. M. K. Nefkens (Univ. of Illinois, Urbana). Rev. Sci. Instr., 35: 1359-60(Oct. 1964).

A technique was developed to allow the gating of a photomultiplier tube by applying reverse bias to the focusing electrode which is interposed between the cathode and first dynode. The gated tube is completely cut off to avoid overload effects and tube damage. (C.E.S.)

37542 LINEAR GATE AND STRETCHER FOR PHOTOMULTIPLIER DYNODE PULSES. Karl B. Keller (Univ. of Illinois, Urbana). Rev. Sci. Instr., 35: 1360-1 (Oct. 1964). (COO-1195-9)

Two circuits are described that perform the operations of gating fast positive pulses, typically from a photomultiplier dynode, upon external command from logic circuits and stretching the gated positive pulses to a length acceptable to a pulse-height analyzer, then inverting and amplifying the stretched pulses. Either circuit may be used alone. Amplitude information is preserved, and the circuits are reproducible without special techniques. (C.E.S.)

37543 PREPARATION OF GERMANIUM DETECTORS. Edwin Kashy (Princeton Univ., N. J.) and Martin E. Rickey. Rev. Sci. Instr., 35: 1364(Oct. 1964).

A method for obtaining proven current-voltage characteristics in lithium-drifted germanium detectors. A way of locating the regions of the detector responsible for large resistive components or breakdown is described. The drifted germanium is dipped into liquid nitrogen and allowed to warm up in air with reverse bias applied. Since the power dissipated per unit area is proportional to the current density in that area, there will be preferential heating, so that in the regions of high current the frost will melt first. These specific areas can then be ground off or cut. (C.E.S.)

37544 MEASUREMENT OF LONG-LIVED ALPHA EMITTERS IN THE AIR. K. Schmidt (Institut für Staubforschung und Radioaktive Schwebstoffe, Berlin). Symp. Tech. Zagadnien Ochrony Promieniowaniem, Warsaw, 338-46(1962). (In Polish)

On the basis of the recommendations of the ICRP (1959), the requirements for air monitoring installation are discussed. The construction and capacity of instruments designed for the determination of long-lived α emitters in the air are described. (tr-auth)

37545 WHOLE-BODY GAMMA RADIATION COUNTER— ITS USE FOR RADIOLOGICAL PROTECTION AT THE IBJ (INSTITUTE FOR NUCLEAR RESEARCH). B. Adamska, S. Pszona, and K. Zarnowiecki (Inst. for Nuclear Research, Warsaw). Symp. Tech. Zagadnien Ochrony Promieniowaniem, Warsaw, 418-34(1962). (In Polish)

The whole-body γ counter, which was constructed at the Institute for Nuclear Research in February 1962, is described. Background elimination for the scintillation counters, basic characteristics of the measurement head, and the calibration method in the 0.4 to 2.75 Mev γ range are described. The results of measurements of the concentrations of ^{137}Cs, ^{40}K, and ^{226}Ra in man are reported. (tr-auth)

37546 HIGH-FREQUENCY RADIATION COUNTER. K. F. Kudu. Usp. Fiz. Nauk, 82: 770-1(Apr. 1964). (In Russian)

A charged particle detector is described that produces a visible discharge across an air gap. A vacuum tube oscillator supplies an r-f potential at 20 Mc to a 70-mm air gap between a pointed conical electrode and a grounded aluminum plate. The apex angle of the electrode is 50°. The power supply to the vacuum tube is alternating voltage, and the circuit is such that the r-f potential reaches the electrode in pulses. When the electrode circuit is matched to the oscillator, a discharge occurs whenever a charged particle enters the sensitive volume between electrode and plate. The discharge is visible in an undarkened room. For counting, a photomultiplier is used. (TTT)

37547 CALIBRATION OF SPECIFIC IONIZATION BY MEANS OF ORGANIC SCINTILLATORS. I. N. Senchuro and V. M. Yakovlev. Vestn. Mosk. Univ., Ser. III, Fiz. Astron., No. 1, 18-20(Jan.-Feb. 1964). (In Russian)

An energy calibration method for organic scintillator counters used for measuring a specific cosmic radiation ionization is described. The method can be used for the energy range exceeding 3 Mev. (tr-auth)

37548 CALCULATIONS OF THE SENSITIVITY OF THICK-WALLED IONIZATION CHAMBERS. A. K. Kaminskii and E. S. Lonskii (Inst. of Scientific-Research in Nuclear Physics, [Academy of Sciences, USSR]). Vestn. Mosk. Univ., Ser. III, Fiz. Astron., No. 2, 32-42(Mar.-Apr. 1964). (In Russian)

A method is offered for calculating the sensitivity of thick-walled ionization chambers used for measuring the γ-ray intensity at $0 < W < 100$ Mev. The calculations are carried out without assuming the equilibrium between the γ radiation and electrons in the chamber wall nor is it assumed that the thickness of the front wall is larger than the mean path of electrons produced by γ quanta in the chamber wall. The method was used for determining the sensitivity of aluminum and graphite chambers. (tr-auth)

37549 X-RAY SPECTROMETER WITHOUT A CRYSTAL STABILIZED BY THE POSITION OF PROPORTIONAL COUNTER AMPLITUDE SPECTRA. V. N. Baronin, Yu. P. Betin, B. I. Verkhovskii, A. I. Ivanov, S. M. Perel'man, I. A. Prager, V. A. Kharlakov, and L. S. Shelkov. Zavodsk. Lab., 30: 498-500(1964). (In Russian)

An x-ray counter consisting of a proportional counter, pre-amplifier, main amplifier, and multichannel amplitude analyzer is described with amplifying factor of $\sim 2 \times 10^3$. A step-wise attenuator was installed at the entrance of the amplifier increasing the amplification factor by 2, 4, and 8. Amplitude spectra for copper and iron powders and their mixtures were analyzed with the spectrometer threshold close to the amplitude maximum of pure copper. The sensitivity of the counter was ~0.5% for Cu. Recordings of the light elements including silicon in air were carried out with a spectrometer without a crystal, with sealed proportioned counter with thin (20 μ) terylene side window, with counter cylinder filled with argon and isoprene at 600 mm Hg pressure, and with zirconium–tritium target. (R.V.J.)

37550 DOSIMETRY. John F. Kircher (Battelle Memorial Inst., Columbus, Ohio). p.49-83 of "Effects of Radiation on Materials and Components." New York, Reinhold Publishing Corp., 1964.

Units of dosimetry and types of dosimetry, such as radioinduced chemical reactions, calorimetry, radioactivation, and radiation damage to solid-state materials and devices are discussed. 108 references are included. (P.C.H.)

37551 DIRECTORY OF WHOLE-BODY RADIOACTIVITY MONITORS (LOW-ACTIVITY LEVELS). (International Atomic Energy Agency, Vienna). 1964. 713p. $14.00 (IAEA).

Information on 111 whole-body radiation counters in

22 countries is summarized in the form of data sheets. Information is included on the addresses of institutions operating the counters, the design features of each monitor, and on intercomparison of many of the factors affecting the performance of the individual monitors are included. Design features are illustrated with 450 diagrams and photographs and performance data are presented in 37 tables. A list of experts in the field is included. 420 references. (C.H.)

37552 MEASUREMENT OF NEUTRON ENERGY EFFECTS USING MULTIPLE THRESHOLD DETECTORS. William Walter Gerken. Thesis, College Park, Md., Univ. of Maryland, 1963. 162p.

Measurements were made of a number of neutron energy effects in the University of Maryland swimming pool reactor (UMR) using multiple threshold detectors. Of the various measurements undertaken, only a cadmium absorber was found to have any significant effect on the neutron energies above 2 Mev. The cadmium resulted in about a 15 per cent decrease in the fast flux measured by the detectors, although the spectrum remained essentially that of the neutron fission spectrum. The thermal fluxes near the center of the reactor were significantly higher with the presence of a water gap or water reflector than would be expected with fuel in this region and were slightly higher with the presence of an air void. A slight increase in the thermal flux adjacent to the graphite reflector was observed. The use of multiple threshold detectors is presented as a means of providing more accurate and reproducible measurements of neutron fluxes. The most efficient material for use as a multiple threshold detector was found to be aluminum 2509 for which three threshold reactions and a thermal neutron reaction could be observed simultaneously. The latest values of threshold reaction cross-sections available in the literature were compiled and adjusted to minimize deviations between measurements of different experimenters. The table of adjusted values for a number of threshold reactions is presented. (A.G.W.)

37553 DEAD-TIME CORRECTIONS. A. Browman (Stanford Univ., Calif.). p.352-4 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

Dead-time corrections to the counting rates of both fast and slow scalers were approximated. (D.C.W.)

37554 A 100-CHANNEL COUNTER FOR AN ELECTRON-SCATTERING SPECTROMETER. L. R. Suelzle and M. R. Yearian (Stanford Univ., Calif.). p.360-1 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

A 100-channel, scintillator-Cherenkov counter detection system to be used with the Stanford 72-in. spectrometer is described. The system will provide a momentum resolution of about 0.1%, while using the full momentum acceptance of the spectrometer. Between beam pulses, data will be transferred from temporary storage binaries to a ferrite-core memory. (D.C.W.)

37555 X-RAY REFLECTION COLLIMATOR ADAPTED TO FOCUS X-RADIATION DIRECTLY ON A DETECTOR. Riccardo Giacconi and Bruno B. Rossi (to American Science and Engineering, Inc.). U. S. Patent 3,143,651. Aug. 4, 1964. Filed Feb. 23, 1961.

An instrument for detecting soft x rays from extraterrestrial sources is designed with a reflection collimator which results in fine angular resolution and high intensification of the incident x rays. The instrument extends the range of x-ray observations to intensities down to 10^{-6} quanta/cm^2-sec with angular resolutions as fine as 10^{-4} radians, and may be used in satellites. (D.L.C.)

37556 SCINTILLATION DETECTOR FOR DETECTING RADIOACTIVE PARTICLES IN A GASEOUS STREAM. Andre Roguin. U. S. Patent 3,144,553. Aug. 11, 1964. Priority date June 2, 1960, France.

A scintillation detector is designed for the monitoring of fuel element sheath failures in a reactor by means of detection of short-lived fission products in the gaseous coolant. The detector is located at the top of an insulating cylinder which acts as a repulsive electrode, while the collecting electrode for the radioactive ions is a piston reciprocating in the cylinder. The operation of the piston electrode and the detector is described. (D.L.C.)

37557 INTEGRATED RADIATION DOSIMETER AND CHARGER. Warren B. Minton. U. S. Patent 3,144,557. Aug. 11, 1964. Filed Apr. 17, 1962.

An integrated radiation dosimeter-charger of the quartz fiber electrostatic charge pencil-type is designed. The charger uses a light-gathering surface to illuminate the dosimeter scale, and its power source is a small mercury battery. (D.L.C.)

37558 APPARATUS FOR THE INDICATION AND MEASUREMENT OF NUCLEAR RADIATION. Reinhard Schneider. U. S. Patent 3,144,558. Aug. 11, 1964. Filed Jan. 19, 1960.

A radiation detector of the pulse type is designed to operate over a wide range of radiation doses. The detector uses an oscillating power supply and associated electronic means for extending low pulse counts and reducing high pulse counts. (D.L.C.)

ISOTOPE TECHNOLOGY

General

37559 MONOMOLECULAR MECHANISM BEHIND ISOTOPIC EXCHANGE BETWEEN BENZYLMERCUROHALOGENIDES AND RADIOACTIVE MERCURY HALIDES. V. A. Kalyavin, T. A. Smolina, and O. A. Reutov (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 156: 95-8(May-June 1964). (In Russian)

The isotopic exchange of n-nitrobenzylmercurobromide with $^{203}HgBr_2$ was studied. The reactant concentrations were varied from 0.015 to 0.18 mole per liter and the temperature from 40 to 70°C. Measurements were made by a paper radiochromatography method. The data at 70°C showed that with equimolar concentrations of the two reactants, the degree of the exchange was independent of the reagent concentration. When the concentration of the organic compound was constant, the initial reaction rate was independent of the $HgBr_2$ concentration. However, at a constant $HgBr_2$ concentration, the initial reaction rate increased with increasing concentration of the organic compound. The slope of the logarithmic curve was equal to 1. These data indicate that the studied reaction is zero order with respect to the $HgBr_2$ concentration and first order with respect to the organic compound concentration; that is, it is a monomolecular reaction. At a constant concentration of 0.6 mole per liter for the reactants, as the temperature was increased from 40 to 70°C, the degree of exchange increased from about 15 to 88% for a reaction time of about 7 hr. From a graph of these data the parameters of the Arrhenius equation were calculated as E = 18 ± 1 kcal/mole and log A = 10.65. (TTT)

37560 RADIOAKTIVINI IZOTOPI I ZRACENJA. (The Radioactive Isotopes and Radiation). Volumes 1, 2, and 3. Ivan Draganić, ed. Belgrade, Naučna Knjiga, 1962. Vol. 1, 132p.; Vol. 2, 352p.; Vol. 3, 240p.

A total of 40 articles are included. The first volume contains the basic principles of radioactivity, including a historical review of Rutherford's and Bohr's studies, excitation and ionization, the nucleus, elementary particles, types of radioactive decay, interaction of radiation with matter from the chemical, physical and biological points of view, radioactive equilibrium, preparation of isotopes, nuclear reactions, preparation of isotopes by means of reactors and accelerators. Chapters are devoted to radiation-chemical processes and to the biological effects of radiation. The second volume acquaints the reader with the principles of measurement, describing GM counters, proportional and scintillation counters, and the experimental problems encountered during the detection and the measurement of various types of radiation, such as dead time, attenuation, counter efficiency, and self-absorption. Concentration, separation, and identification of isotopes, carrier techniques, and electrochemical and chromatographic methods are discussed, together with shielding techniques, contamination and decontamination problems, and design question of importance for isotopic laboratories. The third volume is devoted to the actual and potential applications of radioisotopes in research, industry, agriculture, and medicine, including the migration of ^{32}P in plant and animal organisms, detection and measurement of underground streams, autohistoradiography, and retention of certain isotopes in the body. Among the industrial applications, the activation analysis, γ-defectoscopy, use of isotopes in the pharmaceutical, plastics, and other chemical industry are mentioned. The work represents an enlargement of a laboratory handbook published in 1959 for use in radioisotope courses. (TTT)

Industrial Applications

37561 (A/CONF.28/P/114) PIPELINE WEAR IN IRON ORE TRANSPORTATION. H. L. Tavares, P. E. Aun, A. A. Maestrini, and M. T. Magalhães (Minas Gerais, Brazil. Universidade, Belo Horizonte. Instituto de Pesquisas Radioativas). May 1964. 12p.

The wear of a pipeline used for transportation of iron ore in aqueous suspension was investigated. An irradiated steel tube was placed in a loop carrying a suspension of hematite, and the activity of the slurry was periodically determined. The effects of ore grain size and shape were considered, as well as rounding of the grains in transportation. (D.C.W.)

37562 (A/CONF.28/P/497) SOME APPLICATIONS OF RADIOACTIVE TRACERS IN CIVIL ENGINEERING. M. del Val Cob, A. Plata Bedmar, and J. M. Serratosa Marquez (Spain. Junta de Energia Nuclear, Madrid). May 1964. 16p.

In order to solve certain problems related to the study and control of road surfacing, some tracer experiments have been carried out as follows: 1. Location of burried strain gages ("ventilgeber"). Using two small iodine-131 sources, securely fixed to the "ventilgeber" elastic chamber, it is possible to determine its inclination, while inserted in concrete slabs in the road, with regard to the main tension axis (road axis). The inclination has a great influence upon the strain measurements in concrete, so that its determination is of a great importance. Although the inclination of these devices is originally known, this can change while the concrete is being spread and distributed over the road surface. 2. Location of hidden metallic parts used to determine the settling of the road surface. In order to measure the settling of roads, it is necessary to locate the center of small rectangular metallic plates, which, prior to road surfacing, are placed under it. After the surface has been laid, a small rod, an essential part of the measuring device, must be screwed into them. The location of the center of the plate can be determined by applying beforehand a small radioactive source to it. A scintillation counter appropriately collimated is then used to find the center. 3. Controlling the rate of asphaltic spraying for road surfacing. Several laboratory tests have been carried out to study the distribution of bituminous ligands in the top surface layer. Uniformity in ligand spraying is of great importance, since the ratio ligand-gravel has a decisive influence upon the layer's performance. A method has been developed that enables the determination of the above-mentioned uniformity while the road is being sprayed. Ligand labeled with brominated olive oil-^{82}Br is used to determine the amount of ligand per surface unit on the road by measuring its radioactivity with a scintillation detector which has adequate collimation. (auth)

37563 (A/CONF.28/P/828) CHOICE OF MOST SUITABLE RADIATION CHARACTERISTICS FOR ANY GIVEN GAUGING-PROBLEM. P. Platzek and A. C. Meyer (Neth-

erlands. Nijverheidsorganisatie, TNO, The Hague). May 1964. 15p.

Gaging mostly aims at detection or measurement of mass differences, rather than at determination of an average mass as such. In this respect level indication may be considered as a gaging problem as well, in addition to thickness- or density (difference) measurements. When secondary effects as heterogeneity of radiation, scattering, source dimensions, detector response, etc., are neglected, β as well as γ radiation can in first approximation be supposed to obey the same exponential absorption law. Simple theoretical considerations then show that the average object mass alone determines the choice of the optimum radioisotope (mass attenuation coefficient of principal radiation). In consequence, the required source strength depends on minimum mass difference to be detected, accuracy wanted ($\Delta S/\sqrt{S_D}$), minimum measuring time t, and geometry and detector efficiency. When signals are defined as total count = count rate times measuring time, formulas can be derived to show the intercorrelation of all important variables and parameters in which case the optimum radiation can be chosen. Moreover, a nomogram was constructed to display the situation for optimum as well as for non-optimum conditions. Experimental data show to which extent the simplified assumptions are valid. They justify the trial to consider all mass-difference measurements by means of high-energy radiation as a general problem, which can, in spite of the large variation in objective, always be approached in essentially the same way. (auth)

37564 (A/CONF.28/P/862) TWO RADIOACTIVE SOURCES USED IN AN UNCONVENTIONAL WAY. A. RADIOGRAPHY WITH SPECIOUS SOURCES OF RADIOACTIVE LIQUIDS OR GASES. T. Cless-Bernert and K. Duftschmid. B. A MEGARAD β-SOURCE. T. Cless-Bernert and N. Getoff (Osterreichische Studiengesellschaft fur Atomenergie G.m.b.H., [Seibersdorf, Austria]). May 1964. 10p.

I. For cases in which conventional radiographic methods are not applicable, a method applying radioactive liquids or gases is described. Using very soft gamma emitters, radiographs of sufficient quality of welds, corrosion defects, and deposits inside tubes can be obtained. The method was used to examine the rate of corrosion in the steam vessels of a sugar plant. II. For sterilization or radiation treatment of liquids and gases or other suitable goods, a tube-shaped ^{90}Sr source was constructed. By making use of this geometrical arrangement and of the much higher density of ionization of beta-rays compared to gamma-rays, high irradiation doses may be obtained by relatively small amounts of activity. (auth)

37565 (A/CONF.28/P/876) ADVANCES IN THE USE OF ISOTOPES AND RADIATION SOURCES IN AGRICULTURE AND FOOD SCIENCE. H. Broeshart (International Atomic Energy Agency, Vienna), C. M. Cho, L. E. Engelbert, et al. May 1964. 20p.

An outline is given of some agricultural problems which can most easily be solved by the use of tracer techniques and irradiation. A review is presented of some of the major developments in this field which have taken place since the 2nd Geneva Conference in 1958. Examples are given of some typical modern applications of these techniques in agricultural research and production. Some of the more significant results obtained by the use of tracers and irradiation are described. Particular attention is given to the role of research reactors in agricultural research. (auth)

37566 (NYO-2757-3) DEVELOPMENT OF KRYPTON-85 AS A UNIVERSAL TRACER. CONTINUATION OF PHASE III. AREAS OF APPLICATION. Period Covered: November 1, 1962–October 31, 1963. David Chleck, Richard Maehl, and Orlando Cucchiara (Parametrics, Inc., Waltham, Mass.). Nov. 1, 1963. Contract AT(30-1)-2757. 104p.

Solid sources containing krypton-85 (kryptonates) were prepared by diffusion at temperatures to 650°C and pressures to 50,000 psi. All of the over 85 different solids tested have collected krypton and retained some fraction of this gas with time. Carbon demonstrated the predicted linear dependence of amount of krypton collected on preparation pressure up to 50,000 psi. The profile of krypton-85 distribution with depth was determined experimentally for aluminum, nickel, and steel. The general form of the predicted error function curve was evident with total penetration depths up to 4×10^{-3} cm. Kryptonated calcium carbide was demonstrated as an analytical censor for trace water in organic liquids down to masses of 31 μg. An analysis for aqueous fluoride ion using kryptonated zinc as a titration endpoint detector was sensitive to fluoride concentrations of 1.9 μg F^-/ml. Gas analyses via direct reactions with kryptonates were demonstrated for hydrogen and fluorine. The kinetics and mechanism of these analytical reactions were also studied by kryptonation of the solids. This unique method of study of reactions even at elevated temperatures also permitted investigation of the prevention of catalytic oxidation of hydrogen through use of appropriate covering materials. A different method of gas analyses was demonstrated for the case of SO_2. The SO_2 was dissolved in water to form sulfurous acid which was then permitted to react with kryptonated zinc. SO_2 concentrations of 0.4 ppm are already detectable and a series of improvements outlined. Detection of physical wear by monitoring the krypton-85 released from a kryptonated surface was demonstrated with nickel. The observation that no krypton-85 loss occurs below the previous maximum temperature of a kryptonate was made the basis for a new means of surface temperature measurement. The technique was verified in furnace tests for a number of solids. This method provides a means of surface temperature measurement in systems for which no method was previously available, e.g., gas turbine components. For its own value and for use in friction and wear studies this development was followed with intense interest by segments of the aircraft engine industry and is widely applicable to the whole field of mechanical engineering. (auth)

37567 (TID-19585) APPLICATION OF RADIATION-PASTEURIZATION PROCESSES TO PACIFIC CRAB AND FLOUNDER. Final Summary, November 1962–November 1963. D. Miyauchi, M. Eklund, J. Spinelli, and N. Stoll (Fish and Wildlife Service. Technological Lab., Seattle). Contract AT(49-11)-2058. 156p.

The application of radiation-pasteurization processes to Pacific crab and flounder was studied. The objectives were to determine for Pacific crab meat and flounder fillets the optimum radiation conditions directed toward defining commercial process parameters and to develop chemical, physical, and microbiological tests for measuring changes in quality of radiation-pasteurized crab meat and flounder fillets. Separate abstracts were prepared for chemical, microbiological, and storage studies. (H.M.G.)

For abstracts of individual sections see: 37568, 37569, and 37570.

37568 (TID-19585(p.6-65)) STORAGE LIFE STUDIES. D. Miyauchi and N. Stoll (Fish and Wildlife Service. Technological Lab., Seattle).

With king crab meat, the dose of 0.2 megarad was found to be the optimum for producing a product with good sensory characteristics and good extension of storage life. For the irradiation of king crab meat, vacuum packing was superior to air packing in inhibiting the degradation of quality as measured by sensory and bacteriological tests. The storage life of five different lots of king crab meat vacuum packed and irradiated at 0.2 megarad extended from four to more than six weeks, whereas the storage life of the unirradiated control samples was only one week. With petrale sole fillets irradiated at 0.2 and 0.3 megarad and stored at 42 and 33°F, the air-packed samples were rancid with one week of storage at both temperatures, whereas the vacuum-packed samples had a storage life of four to seven weeks at 33°F and two to three weeks at 42°F. In comparison, the unirradiated control samples had a storage life of four to ten days at 33° and of four to seven days at 42°F. Based on initial tests with dungeness crab meat and Pacific halibut, a radiation dose of 0.2 megarad appears to be optimal. Dungeness crab meat and vacuum-packed halibut irradiated at 0.2 megarad had a storage life at 33°F of three to six weeks and three to four weeks respectively, whereas the unirradiated control samples had a storage life of about one week. For all of the products irradiated at the optimal dose of 0.2 megarad, the storage life at 33° was over two times greater than that at 42°F. The use of the lower storage temperatures is therefore essential in order to take maximum advantage of the extension of storage life made possible by the radiation process. (auth)

37569 (TID-19585(p.66-107)) CHEMICAL STUDIES. John Spinelli (Fish and Wildlife Service. Technological Lab., Seattle).

Chemical changes occurring in irradiated fish were determined and correlated with sensory and bacteriological examination. The objectives of this study were to develop objective chemical indices to be used for the rational production and control of irradiated marine products. The production of trimethylamine (TMA) and total volatile base (TVB) was determined on irradiated and non-irradiated king crab meat, dungeness crab meat, and petrale sole fillets. We conducted these tests on the same samples as were used for sensory and bacteriological examinations in order to establish a relation between the sensory and objective tests. Other chemical tests were conducted on a more limited scale. They included: volatile acids in petrale sole, protein cleavage in petrale sole measured by determining substances reacting with phospho-18-tungstic acid, and low-molecular-weight carbonyls in king crab meat. It was found that although the irradiation process suppresses the amount of TMA and TVB produced in irradiated products as they enter the spoilage phase, good correlation still exists between these indices and bacteriological and sensory tests. In the case of irradiated dungeness crab, however, the production of TMA is almost inhibited; and no relation could be established between TMA, bacteriological, and sensory tests. (auth)

37570 (TID-19585(p.108-44)) MICROBIOLOGICAL STUDIES. Melvin Eklund (Fish and Wildlife Service. Technological Lab., Seattle).

Microbiological changes occurring in irradiated products were followed by determining total plate and psychrophilic counts on all species studied. In addition, yeast and mold counts were determined on the king crab and petrale sole packs. Proteolytic counts were determined on two replicates of petrale sole. It was found that irradiation at 0.1 megarad reduced the original bacterial counts by about 93 percent; at 0.2 megarad by over 98 percent, and at 0.3, 0.4, and 0.6 megarad by over 99 percent. With the commercially available fishery products, psychrophilic counts were generally reduced in count to less than 600 per gram when irradiated at 0.1 megarad and to less than 100 when irradiated at 0.2 megarad. At the higher dose levels of 0.3, 0.4, and 0.6 megarad, the psychrophilic count was reduced to less than 10 per gram. Air-packed king crab and petrale sole fillets supported the growth of yeast and molds in the irradiated packs, whereas they did not in the vacuum packs. Yeasts and molds grew best in the samples irradiated at the higher dose levels. Proteolytic counts were reduced to less than 10^3 per gram at all irradiation levels and failed to increase during the storage periods studied. Higher bacterial populations were required to bring about sensory and chemical changes in the irradiated products than in the unirradiated ones. The bacteria that survive and grow in the irradiated product during the early stages of storage are quite feeble in their ability to produce changes in trimethylamine (TMA) and total volatile base (TVB), and only gradual changes are noted in these two indices until bacterial populations approach 10^8 per gram. In the unirradiated products, sensory and chemical changes occur rapidly after a count of 10^6 bacteria per gram is reached. (auth)

37571 (AEC-tr-6398) PROCEEDINGS OF THE TASHKENT CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY. VOLUME I. Translated from a publication of the Publishing House of the Academy of Sciences of the Uzbekskoi, SSSR, Tashkent, 1961. 564p.

The first volume of the "proceedings" presents the reports of the Plenary Sessions on general problems and prospects of the development of the peaceful uses of atomic energy in the Soviet Union, as well as studies in nuclear physics, radiation effects, and radiochemistry. Separate abstracts were prepared for 62 of the 73 papers presented; abstracts of 10 previously appeared in NSA (15: 6896, 6897, and 31285 and 31286; 17: 21765, 21766, and 22258; and 18: 663, 664, 665, and 13890); the remaining paper is on scientific investigations at the Institute of Nuclear Physics. (R.E.U.)

For abstracts of individual papers see: 36926, 37193, 37194, 37195, 37196, 37197, 37198, 37199, 37200, 37201, 37202, 37203, 37204, 37205, 37206, 37207, 37208, 37209, 37210, 37211, 37212, 37213, 37214, 37215, 37216, 37448, 37476, 37477, 37478, 37479, 37519, 37520, 37572, 37573, 37591, 37686, 37687, 37688, 37765, 37766, 37767, 37768, 37769, 37770, 37771, 37840, 38056, 38073, 38074, 38075, 38076, 38077, 38078, 38079, 38080, 38081, 38082, 38083, 38084, 38085, 38086, and 38087.

37572 (AEC-tr-6398(p.10-23)) PROSPECTS FOR THE PEACEFUL USE OF ATOMIC ENERGY IN THE USSR. P. S. Savitskiĭ and V. I. Sinitsȳn. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z At. Energii, Akad. Nauk Uz. SSR, 1: 15-?(1961).

Some peaceful uses of radioisotopes and nuclear radiations in the USSR are reviewed. (R.E.U.)

37573 (AEC-tr-6398(p.512-20)) INCREASING THE HEAT RESISTANCE OF WIRES WITH POLYETHYLENE INSULATION BY THEIR IRRADIATION WITH IONIZING RADIATIONS. V. L. Karpov, Yu. M. Malinskiĭ, L. V. Mitrofanova, S. T. Sinitsȳn, É. É. Finkel, A. S. Friedman, and

S. M. Chernetsov. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 383-?(1961).

The effects of gamma rays and electrons on the heat resistance of polyethylene-insulated cables were studied. Optimum conditions for enhancement of heat resistance are discussed. (R.E.U.)

37574 APPLICATIONS OF INTENSE RADIATION SOURCES TO BIOSYNTHETIC FOODS AND MEDICAMENTS: BASIC CONCEPTS FOR USE IN ORIENTING A RESEARCH PROGRAMME. I. R. Mouton (Universite Libre, Brussels). Ind. At., 8: Nos. 5-6, 53-64(1964). (In French)

A critical synthesis is presented of the application of intense radiation sources to foods and biosynthetic medicaments. The justification for these new applications are first explored. Their potentialities and the limitations to their applicability are then considered. (tr-auth)

Power Application

Refer to abstract 37872.

Separation and Production

Refer also to abstract 38550.

37575 (A/CONF.28/P/89) DEDUCTIONS BASED ON STUDIES OF URANIUM ISOTOPE SEPARATION AND FRENCH ACHIEVEMENTS IN THIS FIELD. Claude Frejacques and Robert Galley (France. Commissariat a l'Energie Atomique, Paris). May 1964. 13p.

The work carried out in the field of uranium isotope separation, by gaseous diffusion and by ultracentrifugation, is reviewed. An economic estimate of the various parameters involved in the cost is given, and it is shown that only very large gaseous diffusion plants, corresponding to a program of enriched uranium reactors of at least 4000 Mw(e) to be installed yearly, can give an economically acceptable enriched uranium production. (auth)

37576 (A/CONF.28/P/90) PHYSICO-CHEMICAL SEPARATIONS OF STABLE ISOTOPES. Fernande Botter, Philippe Molinari, and Grégoire Dirian (Commissariat à l'Energie Atomique, Paris). May 1964. 17p.

Work on the separation of hydrogen isotopes by thermal diffusion and by chromatography, the enrichment of ^{124}Xe by thermal diffusion, the enrichment of lithium-6 or -7 by chemical exchange and on ion exchange resins, and the enrichment of ^{46}Ca by electromigration in fused salts is reviewed. (C.E.S.)

37577 (A/CONF.28/P/91) STUDY ON THE PRODUCTION OF HEAVY WATER IN FRANCE. Hernard Lefrancois (Houillères du Bassin du Nord et du Pas de Calais), Jean-Marie Lerat, and Etienne Roth. May 1964. 14p.

The research program in France on heavy water production by exchange between ammonia and hydrogen is outlined, including pilot plant studies with pressures as high as 500 kg/cm^2 and temperatures as low as -50°C, reaction and technological studies, and studies of two possible industrial processes. (D.C.W.)

37578 (A/CONF.28/P/388) EXPERIMENTAL PRODUCTION OF STABLE ISOTOPES. I. G. Gverdtziteli, T. A. Gagooa, G. N. Muskhelishvili, U. V. Nikolaev, E. D. Oziashvili, and G. A. Thevzadze (U.S.S.R.). May 1964. 19p.

The basic experimental data and general technological scheme of the Tbilisi plant's performance are given. In the first place production of boron and nitrogen isotopes B^{10}, B^{11}, and N^{15} was organized. Two methods are used to produce boron isotopes: low-temperature distillation of boron trifluoride and exchange distillation of its methyl ether complex. Schemes and parameters of columns to produce 25 kg/year of boron-10 are given. The nitric oxide-nitric acid exchange process is used to separate nitrogen isotopes. Schemes and parameters of columns to produce 4.5 kg/year of nitrogen-15 are given. The system of automatic control is described, which includes a number of special sensing elements, actuating mechanisms, and regulators. In the second place production of isotopes O^{18} and N^{15} is envisaged by low-temperature distillation of nitric oxide and isotopes Ne^{22}, Ar^{36}, C^{13}, and Kr^{86} by diffusion through another gas. The results of calculations and experimental data are given. (auth)

37579 (A/CONF.28/P/439) SOME JAPANESE WORKS ON CHEMICAL SEPARATION OF URANIUM ISOTOPES. Hidetake Kakihana (Tokyo Inst. of Tech.). May 1964. 15p.

The theoretical studies have proved that the mixture of U(IV) and U(VI) should be a favorable system, if the electron exchange reaction between the isotopes could be catalyzed. Cation and anion exchange resins were ascertained as very promising catalyzers. For example: rate of electron exchange in cation exchange resin/rate of electron exchange in solution = $10^3 - 10^4$. Better separation factors were observed for U(IV) (1.0007) than U(VI) (1.0000). Much higher separation factors (1.0014) were obtained for the mixed systems of U(IV) and U(VI), which could be explained by the effective contribution of the isotopic effect in electron exchange reaction between U(IV) and U(VI). At the front of the U-band in an ion exchange membrane an appreciable enrichment of ^{235}U was observed just as in the case of Li isotope. By superimposing a-c similar favorable effects to N isotopes were observed on U isotope fractionation. An apparatus based on the idea of combining two processes, ion exchange elution and ionic migration, was devised to aim the synergetic effect of them as well as the continuous operation. Through this apparatus the continuous flow of enriched ^6Li (e.g., $^7Li/^6Li$ = 11.61) was obtained at the cathode side, with the depleted ^6Li (e.g., 12.81) at the anode side. Similarly the enrichment of ^{235}U was observed in the flow of the cathode side. (auth)

37580 (A/CONF.28/P/440) ISOTOPE SEPARATION BY CONCURRENT GAS CENTRIFUGE. Akira Kanagawa, M. E. Yoichi Takashima, and Yoshitoshi Oyama (Tokyo Inst. of Tech.). May 1964. 12p.

The relations between the separative power, the separation factor, the gas flow rate, the length of cylindrical rotor, the cuts and the radii to be extracted have generally been analyzed concerning isotope separation by the concurrent type of gas centrifuge and compared with those in the case of the countercurrent type. The more generalized differential equation than that used by Cohen, which can be applied to centrifugal separation through (n + 1) cylindrical thin concurrent streams, has been obtained, and solved in the cases of n = 1 and n = 2. First of all, in the case of n = 1, already solved by Cohen, the relations of gas feed rate per length of the rotor to both the separation factor and the separative power have been calculated and compared with those in the case of countercurrent flow using a parameter of Z/r_0 which is the ratio of the length of rotor to the radius. As a result, it has been shown quantitatively that

as Z/r_0 increases, remarkably more flow rate should be required in the concurrent flow to get the same value of separative power as that in the countercurrent flow, and the flow rate in the concurrent flow, however, is comparable with the circulation rate in the countercurrent flow. In the case of n = 2, a higher maximum separative power is possible even if the inner two thin streams are mixed at the exit, than in the case of n = 1. The optimum condition in this case is as follows; $r_1/r_0 = 0.45$, $r_2/r_0 = 0.6$, $\theta_1 = 0.19$ and $\theta_2 = 0.31$, where r_1 and r_2 are the radii of the inner two streams and θ the cut. The maximum value of the separative power is 1.066 times that in the case of n = 1, and the optimum flow rate is 1.130 times. As a result of these analyses, it is suggested that the thickness of the flow path which should exist more or less in practice may bring better separation performance. (auth)

37581 (A/CONF.28/P/457) SEPARATION AND PURIFICATION OF CERTAIN RADIOISOTOPES FOR MEDICAL USE. A. A. Abdel-Rassoul, H. Fouad, A. Abdel-Aziz, S. S. Wahba, and S. Mohammed (United Arab Republic. Atomic Energy Establishment, Inshas, Egypt). May 1964. 16p.

The separation methods described are recommended for producing ^{35}S, ^{45}Ca, ^{46}Sc, ^{48}Sc, ^{111}Ag, and ^{199}Au in carrier-free state, ^{51}Cr of increasing specific activity, carbon-coated preparations of mixed ^{198}Au and ^{111}Ag and carbon suspensions with inactive gold impregnated with ^{111}Ag. All radionuclides separated have a radiochemical purity exceeding 99%. (auth)

37582 (A/CONF.28/P/465) ENRICHMENT OF LOW-LEVEL TRITIUM BY THERMAL DIFFUSION FOR HYDROLOGICAL APPLICATIONS. B. Th. Verhagen and J. P. F. Sellschop (University of Witwatersrand, Johannesburg). May 1964. 16p.

The two-stage thermal diffusion column system was developed for tritium enrichment. The critical parameters of the system and the performance characteristics are described. Enrichment factors of 800 in equilibrium periods of 30 hours are achieved. The use of such columns in a tritium dating and tracing laboratory are critically discussed and compared with other techniques. (auth)

37583 (A/CONF.28/P/482) SEPARATION OF STABLE ISOTOPES BY THE GAS CENTRIFUGE METHOD. INFLUENCE OF THE AXIAL PRESSURE ON THE SEPARATION OF ARGON ISOTOPES. J. Jordan, W. Kolbe, and R. Borges da Silva (Sao Paulo, Brazil. Universidade. Instituto de Pesquisas Tecnologicas). May 1964. 19p.

The installation for stable isotope separation by the gas centrifuge method, as well as the experiments performed in order to investigate the influence of the gas pressure at the axis of the centrifuge rotor on the separation of argon isotopes, are described. The installation consists of three thermally controlled countercurrent gas centrifuges, developed, as model ZG 3, by Groth and co-workers. These centrifuges are arranged in a two-stage cascade for the separation of argon isotopes. The description of this cascade, in which each centrifuge may also be operated as a single element, is given. The influence of the axial pressure on the separation of argon isotopes was investigated with one of these centrifuges, by measuring the enrichment as a function of the throughput of the gas, under variation of the temperature difference between the rotor covers and for several axial pressures of the gas in the centrifuge rotor. The data from these experiments are used in order to calculate the enrichments at total reflux, as well as the separative power of the centrifuge as a function of the gas throughput. The results show that the enrichment and the separative power decrease as the axial pressure decreases and that greater optimal temperature differences between the rotor covers are necessary at the smaller axial pressures. For certain of these temperature differences, the presence of a maximum was observed at the separative power vs throughput curves, which were provided by the experiments done with the smallest investigated axial pressure. The results are further discussed in view of the dependence of the separative power on the flow profile of the gas inside the centrifuge rotor. (auth)

37584 (A/CONF.28/P/491) THE PRODUCTION OF STABLE ISOTOPES IN SPAIN. M. M. Urgell (Spain. Junta de Energía Nuclear, Madrid), J. Iglesias, J. Casas, J. M. Savirón, and M. Quintanilla. May 1964. 24p.

Work carried out under the stable-isotope-production program on the separation of stable isotopes by ion-exchange chromatography and thermal diffusion is described. With the former technique, a study was made of the separation of ^{14}N, ^{15}N, ^{10}B, and ^{11}B. This work included laboratory-scale experiments carried out with a view to determining the separation factor by means of the breaking-point technique. (auth)

37585 (A/CONF.28/P/496) STUDIES ON THE PRODUCTION OF HEAVY WATER AT J.E.N. J. Alvarez, M. Gispert, A. Maria, J. L. Otero, and J. L. Rojas (Spain. Junta de Energía Nuclear, Madrid). May 1964. 14p.

Theoretical studies performed on rectifying columns and cascades and on electrolytic cascades with burners and reactors are outlined; and the electrolysis plant developed for production of water enriched to 2% in D_2O is described, together with the electrolysis and burner pilot plant and the rectification pilot plant by which the enriched water is concentrated to 99.8% D_2O. The float and infrared spectrometric methods used to determine D_2O concentrations are also discussed. (D.C.W.)

37586 (A/CONF.28/P/557) A NEW DISTILLATION TECHNIQUE FOR ISOTOPE CONCENTRATION. M. Silvestri, G. C. Angelino, and B. Brigoli (Centro Informazioni Studi Esperienze, Milan). May 1964. 18p.

A liquid can be forced to rise on a vertical surface in the form of liquid thin film, if a gas with a sufficiently high velocity is used as raising agent. Under these conditions mass transfer takes place in isothermal flow. The application of cocurrent two-phase annular flow as a contacting mechanism for the separation of the components of an isotopic mixture was studied. As a first application, the separation of oxygen-18 and deuterium by water distillation at room temperature, in the presence of an inert gas, was studied. A 100-stage distillation plant was designed and assembled in order to test the feasibility and the best conditions in which a good contact between the two phases occurs. Air was chosen as the gas carrier. Mass transfer and hydrodynamic behavior of the plant was studied in 2,000 hours of operation. A further development of the contact technique was the application of this principle to conventional distillation column in a steam-water system; a suitable type of plate was designed for this purpose. Mass transfer and the hydrodynamic behavior of a plate were studied in experiments carried out at temperatures ranging from 90 to 110°C in a steam-water system. In many respects this type of plate proved to be advantageous as compared to conventional distillation plates, so that the investigation was pursued on a laboratory-scale column assembled with 24 plates. The efficiency, pressure drop, and equilib-

rium time of the column were investigated. The column was designed for heavy water separation by fractional distillation, at temperatures ranging from 90 to 101°C. It is shown that cocurrent plates columns make possible a strong reduction in size, as compared to conventional bubble-plate columns; the former appear to be easy to control and show a short equilibrium time and a low material hold-up. (auth)

37587 (A/CONF.28/P/567) THE ECONOMIC SEPARATION OF STABLE ISOTOPES ON A COMMERCIAL SCALE. A. O. Edmunds, E. Blancke, and E. Rogers (Twentieth Century Electronics Ltd., Croydon, Surrey, England). May 1964. 13p.

The separation of isotopes of boron and carbon has been carried out for some time in the U.K. The fluctuating demand required a special approach to plant design in order to obtain an economic production unit. Development has taken the form of a multiplicity of basically independent units as it has been found that they give maximum flexibility from the point of view of output, range of enrichments and utilization of raw materials. The technical problems relating to the use of boron trifluoride etherate in chemical exchange/distillation plant arise almost entirely from two of its properties– its highly corrosive nature, particularly in the presence of small amounts of moisture, and its tendency to decompose at quite moderate temperatures. The following developments have been carried out with these limiting properties very much in mind. Boiler designs, column packing, partial pressure control, and extraction methods all affect the operating temperature in direct or indirect ways. Packing of high efficiency with low pressure drop has been developed, new boilers have been designed, and column head and extraction controls have been improved. The merits of cascade and single step units (enriching from natural abundance to 90% boron-10 in a single stage) are discussed and the latest design of single stage unit outlined. The present plant consists of 8 such units producing 25 to 30 kg per year. Economic considerations also have an important bearing on design and such aspects as simplicity of operation and construction must be kept in mind. Equilibrium time is particularly important and the units described can be in full production within five weeks of commissioning. Thus, a decision to increase production can be implemented relatively quickly. As far back as 1949 some separation of carbon-13 was being carried out by the U.K. Atomic Energy Authority. The demand is still only of the order of grams per week and, in the new plant, development has been directed toward economies both in the use of coolant (the main expense in manufacture) and on improving reliability. The commissioning of the new plant has doubled our production of carbon-13 and these developments are fully discussed. (auth)

37588 (A/CONF.28/P/639) SEPARATION BY COUNTERCURRENT-EXCHANGE-ELECTROLYSIS APPLIED ON LITHIUM ISOTOPES. G. J. Arkenbout (Netherlands. Toegepast Natuurwetenschappelijk Onderzoek, Utrecht). May 1964. 14p.

The separation of the lithium isotopes by countercurrent-exchange-electrolysis was studied. It was found that when a column containing sand with a particle size of 0.35 to 0.5 mm is properly treated, it permits a countercurrent transport of lithium amalgam and a solution of lithium chloride in dimethyl formamide. The reflux at the bottom of the column, where the lithium is transported from the amalgam to the electrolyte solution (anodic reflux), was realized by a continuous method based on exchange-electrolysis. The cathodic reflux is obtained by evaporating the solvent dimethyl formamide, transferring the lithium chloride into water, and electrolyzing the lithium chloride solution in water. Experiments carried out during 20 to 40 hr in an exchange column with a length of 1 to 2 m resulted in an increase of ^{6}Li content from 7.5 to 12.0% at the bottom of the column and a decrease of ^{6}Li content from 7.5 to 5.8% at the top of the column as determined by mass-spectrographic analysis (the data correspond with separation factors of 1.68 and 0.76, while the elementary separation factor amounts to 1.05). (auth)

37589 (A/CONF.28/P/753) TECHNICAL AND ECONOMIC CONSIDERATIONS FOR PRODUCING 200 T/YEAR OF HEAVY WATER IN INDIA. P. G. Deshpande, D. C. Gami, and S. Nagaraja Rao (India. Atomic Energy Establishment, Trombay). May 1964. 12p.

The technical and economic considerations for producing 200 ton/year of heavy water in India utilizing middling coal as the principal source of heat to the system by locating the plant near a coal mine or a coal washery is discussed. The process to be adopted for this plant consists of the H_2S–H_2O dual temperature exchange for pre-enrichment, followed by water distillation for the final enrichment to reactor-grade heavy water. Since the cost of energy forms a major part of the operating cost of this process, a location near a cheap fuel source has an important bearing on production costs. The cost involved in expanding the present heavy water plant (14 ton/year) at Nangal to produce 200 ton/year by pre-enrichment of the feed to the electrolyzers by an H_2S–H_2O exchange process and providing additional capacity in the final enrichment step of hydrogen distillation was worked out. A comparison of the operating costs for these two plants shows that the plant near a coal mine or a coal washery will produce heavy water at a lower cost. (auth)

37590 (A/CONF.28/P/754) ANALYSIS OF OPERATING EXPERIENCE OF A HYDROGEN DISTILLATION PLANT. D. C. Gami and A. S. Rapial (India. Atomic Energy Establishment, Trombay). May 1964. 20p.

A hydrogen distillation plant for the production of heavy water has been operating at Nangal since August 1962. The main problems encountered during the initial commissioning and subsequent operations have been described. Power consumption, refrigeration requirements, gas losses, and column efficiencies have been analyzed. On the basis of data obtained and the experience of operating a heavy water plant, it is considered that lower production costs can be achieved if hydrogen distillation is carried out under vacuum. Various problems likely to be encountered, and their suggested solutions along with process design and estimated operating costs of a new plant are presented. (auth)

37591 (AEC-tr-6398(p.34-48)) PRODUCTION OF RADIOACTIVE ISOTOPES IN THE USSR. E. E. Kulish and G. M. Fradkin. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 34-?(1961).

The production of radioisotopes, labeled compounds, and radiation sources in the Soviet Union is reviewed. (R.E.U.)

37592 FORMATION OF RADIOISOTOPES THROUGH NEUTRON-GAMMA REACTION. László Szirtes and László Zsinka (OAB Izotop Intezete, Budapest). Energia Atomtech., 17: 195-200(Apr. 1964). (In Hungarian)

The isotopes were prepared by irradiating special target materials in the VVR-2 type research reactor. Oxides of Si, Sc, Mn, and Fe; metallic Ca, Zn, Ge, Ga, Se, Cd, Sb, W, and Ir; and Ta and Cs carbonate were used in the prep-

aration of the targets. The expected specific activity A in mC/g after a given period of irradiation was calculated from the following formula: $A = 1.63 \times 10^{-8}\ a\ \sigma\ \phi\ (1/M)\ (1 - e^{-0.693(t/T)})$, where a represents the natural abundance of the isotope in question; σ is the thermal neutron cross section; ϕ is the thermal neutron flux; M is the atomic or molecular weight; T is the half-life of the isotope; and t is the period of irradiation. Special formulas were derived for the simultaneous formation of parent and daughter elements, when the half-life of the daughter exceeds that of the parent. The targets were dissolved and recrystallized after the irradiation in order to obtain the desired compounds of the isotopes formed. The results of the activity measurements on isotopes by an absolute method agreed with the literature within an error of ±5%. A 128-channel analyzer was used to determine the energy of the gamma emitters, checking the curves derived against reported data. (TTT)

37593 SEPARATION OF CALCIUM ISOTOPES IN AN AMALGAM SYSTEM. Donald Zucker and J. S. Drury (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 41: 1678-81 (Sept. 15, 1964).

Concentration of the heavy isotopes of calcium by means of the chemical exchange reaction $^{46}Ca_{(Hg)} + {}^{40}Ca^{2+}_{(solution)} = {}^{40}Ca_{(Hg)} + {}^{46}Ca^{2+}_{(solution)}$ was studied. The reaction was found to be technically feasible as a pre-enriching process for Calutron feed material; its economic attractiveness depends upon a sufficiently large scale of application. At 25°C, the single-stage separation factor for isotopes differing by one unit of mass was 1.0013 ± 0.0003 (95% C.I.). The half time of exchange of calcium was less than 7 sec. The solubility of calcium in mercury varied from 0.562 M at 0°C to 0.908 M at 36°C. The integral heat of solution of calcium in mercury was given by the least-squares equation, $-\Delta H \pm 0.2$ (95% C.L.) = 45.43 − 0.56 M. (auth)

37594 THE SEPARATION OF LIGHT GASEOUS ISOTOPES BY MASS DIFFUSION COLUMNS. PART I. W. J. de Wet and J. Los (FOM-Laboratorium voor Massascheiding, Amsterdam). Z. Naturforsch., 19a: 740-6(June 1964).

A theoretical investigation of the factors affecting the efficiencies of mass diffusion columns, with particular emphasis on columns operated with partition membranes, for the separation of light gaseous isotopes, is extensively treated. Expressions are derived for the theoretical maximum separation factor and separative power and the optimum flow profile. The effects of partition membranes on column efficiencies are discussed and equations are derived to assess the performances of such columns. It appears that the membrane position in a column is rather critical and means to obviate unfavorable effects due to this are suggested. Existing experimental results of Gverdtsiteli et al., corroborate some of the main theoretical conclusions. (auth)

37595 THE SEPARATION OF LIGHT GASEOUS ISOTOPES BY MASS DIFFUSION COLUMNS. PART II. W. J. de Wet and J. Los (FOM-Laboratorium voor Massascheiding, Amsterdam). Z. Naturforsch., 19a: 747-55(June 1964).

The design of mass diffusion columns operated with partition membranes, for the separation of light gaseous isotopes, is discussed. A theoretical analysis of experimental results obtained indicates that a good agreement between experimental results and theory is only obtained at low column pressures and moderate countercurrent flow rates. At fairly low countercurrent flow rates mixing effects due to viscous dragging and gas solubility by the condensate appear to be considerable whereas excessively high countercurrent flow rates, on the other hand, also seem undesirable. Some suggestions are proposed to obviate impairing effects at least to some extent. (auth)

37596 THERMAL DIFFUSION OF ISOTOPES IN PURE MOLTEN LITHIUM METAL. Aadu Ott and Arnold Lundén (Chalmers Inst. of Tech., Goteborg). Z. Naturforsch., 19a: 822-3(June 1964).

Thermal diffusion in the molten metal causes an enrichment of the light lithium isotope at the hot side. The Soret-coefficient for the temperature range 325–550°C is $(1.97 \pm 0.09) \times 10^{-4}\ degr^{-1}$, i.e., considerably larger than in molten or solid lithium compounds. (auth)

MATHEMATICS AND COMPUTERS

Refer also to abstracts 36932 and 37472.

37597 (A/CONF.28/P/168) EVALUATION, STORAGE, AND PROCESSING OF NUCLEAR DATA FOR REACTOR CALCULATIONS. J. S. Story (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Establishment, Winfrith, Dorset, England), M. F. James, W. M. M. Kerr, K. Parker, I. C. Pull, and P. Schofield. May 1964. 15p.

Through the use of large computers reactor calculations are much more precise and detailed than was possible in the early years of the atomic energy industry. This advance is being supported by large numbers of neutron cross section measurements of improved accuracy and extent. However, preparation of the derived quantities needed for reactor calculations can be extremely laborious. To surmount this difficulty in a systematic way workers in the UKAEA are building up a data library on punched cards and magnetic tape of the complete range of basic nuclear cross sections which are needed, with versatile processing programs to generate the derived quantities. The process of evaluation of cross sections for the library is discussed. For a library to be useful in reactor calculations it must contain a complete range of data for the most important materials. Thus the initial stage of its construction is quite a large undertaking: it is now complete so far as the UKAEA data library is concerned. At the present time this contains neutron cross section data in the range 1 to 15 Mev for 39 materials, including angular and energy distributions of secondary neutrons. Some gamma ray cross sections in the range 10 kev to 20 Mev are also available. The format of the library is very flexible, and both tabular and parametric representations of the data are allowed. The latter have considerable advantages in some parts of the energy range if computer programs are available for their interpretation. Some such programs are in use and others are being developed. Because the data are very numerous several ancillary programs are used to mechanize jobs such as checking, altering, and printing the library. The principal "processing programs" developed for general use with the library are GALAXY, which generates multigroup cross sections, and DICE, which prepares the data for Monte Carlo calculations and aids consultation of the prepared data. Work is summarized on the evaluation of data on the thermal neutron scattering law. The differential scattering cross section cannot be measured over the whole range of initial and final energies and scattering angles at all the temperatures required. So it is necessary to make considerable use of theory in interpreting and extrapolating the measurements. The adequacy of the scattering laws obtained in this way are checked by appeal to measurements of neutron spectra in moderating assemblies. (auth)

37598 (ORNL-TM-942) AN INVESTIGATION OF THE EQUATION-SOLVING ROUTINE MATEQ. Melvin Tobias and Marina Tsagaris (Oak Ridge National Lab., Tenn.). Aug. 20, 1964. Contract [W-7405-eng-26]. 4p.

The equation-solving routine MATEQ was tested on the problems $Ax = b$, $A^2x = Ab$, $A^3x = A^2b$ to find the solution vector x. The elements a_{ij} of A were 2 if $i = j$, -1 if $|i - j| = 1$, and 0 if $|i - j| > 1$. The vector b was selected so that all the $x_j = 1$. The orders of A ranged from 3 to 30 and the P-condition numbers varied from 3.65 to 4×10^7. The results indicate that MATEQ is better at solving large numbers of simultaneous equations than is generally realized. The worst result obtained was a 10% error for the poorest conditioned matrix examined. "Bad" answers obtained with MATEQ may often not be caused by the equation solver, but rather by round-off errors in the matrix elements themselves. (auth)

37599 (TID-20961) TECHNICAL PROGRESS REPORT. PART I. HIGH-SPEED COMPUTER PROGRAM. PART II. ILLIAC II SYSTEM PROGRAMMING, MAINTENANCE AND OPERATION. PART III. CIRCUIT RESEARCH PROGRAM. PART IV. IBM 7094-1401 SYSTEM. PART V. GENERAL LABORATORY INFORMATION. (Illinois. Univ., Urbana. Digital Computer Lab.). May 1964. Contract AT(11-1)-415. 65p.

A summary is given of the development of a high-speed computer; programming, maintenance, and operations of ILLIAC II; electronic studies (tunnel diode theory, hot-electron diode studies, and analysis of transient responses of nonlinear systems); and programming and operations of an IBM 7094-1401 system. (T.F.H.)

37600 VARIATIONAL SOLUTIONS TO THE BRILLOUIN-WIGNER PERTURBATION DIFFERENTIAL EQUATIONS. William J. Meath and Joseph O. Hirschfelder (Univ. of Wisconsin, Madison). J. Chem. Phys., 41: 1628-33(Sept. 15, 1964).

Variational techniques for the Brillouin-Wigner (BW) perturbation theory, analogous to the Hylleraas and Sinanoğlu principles in Rayleigh-Schrödinger (RS) theory, were derived. A practical method of applying this approach to BW theory, which does not require the knowledge of the exact BW wavefunctions, is discussed. Using this method an upper bound to the exact total energy was obtained for systems in the lowest energy state of a given symmetry. Finally, a convenient matrix method of applying the variational principles is suggested and degenerate BW theory is discussed briefly. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

General

Refer also to abstracts 38001, 38255, 38265, 38302, and 38369.

37601 (A/CONF.28/P/58) STUDY AND MANUFACTURE OF PLUTONIUM FUELS. Pierre Bussy, Jean-Pierre Mustelier, and Roger Pascard (Commissariat à l'Energie Atomique, Paris). May 1964. 15p.

The studies carried out on the properties of fast neutron reactor fuels, the manufacture of fuel elements, and their behavior under irradiation are broadly outlined. The metal fuels studied are the ternary alloys U–Pu–Mo, U–Pu–Nb, U–Pu–Ti, and U–Pu–Zr; the ceramic fuels are mixed uranium and plutonium oxides, carbides, and nitrides obtained by sintering. Results are given on the manufacture of uranium fuel elements containing a small proportion of plutonium, used in a critical experiment, and on the first experiments in the manufacture of fuel elements for the reactor Rapsodie. The results of irradiation tests carried out on the prototype fuel pins for Rapsodie are described. (auth)

37602 (A/CONF.28/P/59) RECENT DEVELOPMENTS IN REFRACTORY FUELS. A. Accary and R. Delmas (Commissariat à l'Energie Atomique, Paris). May 1964. 15p.

The main part of the work carried out in the field of ceramic fuels by the Commissariat à l'Energie Atomique during recent years, has been in the direction of uranium dioxide and the uranium–carbon systems. Uranium dioxide is being studied with the aim of using it as a fuel in the first core of EL-4, in which an integrated thermal conductivity of 29 W/cm is expected at the hottest point for a surface temperature of about 750°C. A process was developed for preparing a dioxide powder of suitable characteristics and for sintering this powder, and the main properties of the material obtained were evaluated in the light of the conditions under which they are to be used: micro-structural aspect and pore distribution; mechanical and thermal behavior in cylindrical form; control of excess oxygen in the industrial products; and behavior of the gaseous fission products at high temperatures after or during the course of irradiation. The aim in the case of uranium carbides was to determine the conditions of industrial manufacturing of a suitable fuel with a composition close to UC. (auth)

37603 (A/CONF.28/P/68) SPECIAL GRAPHITES. P. Leveque, F. M. L. Lang, and J. Rappeneau (France. Commissariat à l'Energie Atomique, Paris). May 1964. 19p.

The processing of forged graphite, pyrocarbons, high-density graphite, agglomeration of graphite powders by cracking of natural gas, and impervious graphites is discussed. The physical properties of these products and their reaction with various oxidizing gases are described. The first irradiation results are also given. (auth)

37604 (A/CONF.28/P/71) Fe Al 40, A NEW CANNING MATERIAL FOR REACTORS USING REFRACTORY FUEL. Gérard Sainforth, Gérard Cabane, and Marc Salesse (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 13p.

Fe Al 40, owing to its high aluminum content, is more suitable than stainless steels for nuclear applications. It has two advantages: its nuclear cross section is half that of 18-10 stainless steels; and its compatibility with fuel elements and heat-extracting fluids is exceptionally good. The vacuum casting of pure iron and aluminum, together with additions of scavenging elements, gives a very clean alloy with sufficiently reduced brittleness at high temperatures as to allow transformation with a very good yield. Studies of smelting and transformation have enabled the optimum composition and the best industrial fabrication conditions to be established. The mechanical properties of extruded or rolled products are dependent on the ferritic ordered structure of the alloys. Welding of Fe Al 40 is facilitated by the fact that this alloy remains ferritic up to its melting point (1350°C); however it is sensitive to hot short cracking and grain swelling. Several welding processes have been successfully applied to this alloy, under conditions where the superficial alumina layer was removed. This very impervious oxide skin gives Fe Al 40 a unique resistance to corrosion. No diffusion reaction has been detected either with uranium dioxide up to 800°C, or with uranium carbide up to 700°C. (auth)

37605 (A/CONF.28/P/101) THE USE OF BERYLLIUM AS A CANNING MATERIAL. THE PROBLEMS ARISING FROM THE BRITTLENESS OF THE METAL, AND THEIR PRESENT SOLUTIONS. Michel Weisz and José Mallen (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 13p.

The high fuel can temperature and coolant pressure (600°C, 60 kg/cm^2) in the EL-4 reactor necessitates the improvement of the ductility of the beryllium tubes which are to be used as the cans. Studies were made of the room-temperature brittleness, plastic anisotropy, and hot brittleness of Be. The effects of impurities and extrusion on the ductility were studied. It was found that the use of cast Be resulted in more ductile tubes which should be adequate for use as El-4 fuel cans. (D.L.C.)

37606 (A/CONF.28/P/152) PRELIMINARY DEVELOPMENT OF DISPERSED FUELS IN THE U.K.A.E.A. F. S. Martin (United Kingdom Atomic Energy Authority. Reactor Group, Springfields, Lancs, England); F. J. P. Clarke, R. W. M. D'Eye, and D. T. Livey. May 1964. 18p.

The reasons for developing non-metallic dispersed ceramic fuels in the U. K. and their development status are discussed. Two systems were chosen for detailed development: a dispersion of dense uranium dioxide in beryllia, and a dispersion of coated uranium carbide fuel in silicon carbide. (auth)

37607 (A/CONF.28/P/156) LONG-TERM STUDIES OF MATERIALS PROBLEMS IN GAS-COOLED REACTORS. A. T. Churchman, J. H. Buddery, B. Edmondson, G. W. Greenwood, R. V. Hesketh, and G. K. Williamson (Gt. Brit. Central Electricity Generating Board. Berkeley Nuclear Labs., Berkeley, England). May 1964. 14p.

Examples are given of work undertaken by the C.E.G.B. at its Berkeley Nuclear Laboratories in support of the British civil nuclear power program. The problems studied fall into three groups: (1) Those capable of restricting the availability and reliability of operation of a gas-cooled uranium-Magnox reactor. The incidence of fast bursts,

currently one in 10^4 fuel elements, could be lowered by at least 100 times by reducing the oxidation rate of uranium. It is shown that a UAl_3 layer formed by the diffusion of aluminum into uranium reduces the oxidation rate of uranium in carbon dioxide by some 200 times without significantly affecting neutron economy. (2) Those capable of restricting fuel element lifetime by setting up a systematic failure mode. Quantitative theories are proposed, supported by experimental evidence, which define (a) the conditions necessary to limit distortion when metallic uranium fuel elements are used in a temperature gradient such that both α and β phases are present; (b) the circumstances which lead to coalescence of fission-gas bubbles with resultant volume changes in the uranium. The creep behavior of magnesium and Magnox above 250°C is rationalized in terms of a constant activation energy, a variable stress index and a grain size index at stresses above 200 psi and Herring-Nabarro creep below 100 psi. (3) Those capable of affecting the lifetime of the plant or its operating parameters. The effects of thermal and radiolytic oxidation on the chemical reactivity of nuclear graphite toward air in the absence of fast neutrons is discussed, together with the mechanism of carbon deposition by thermal polymerization of carbon suboxide: the kinetics of polymerization and the structure and properties of the polymer are defined. The electron microscopy of graphite has shown that the dislocation behavior and structure in graphite are those predicted by conventional theory. It is shown that the detailed dislocation arrangement in polycrystalline graphite accounts for many of the observed mechanical properties. Thermal cycling and low temperature creep behavior of graphite are predicted. The conditions under which graphite could be expected to support large strains are discussed in relation to the irradiation creep phenomenon. In anisotropic materials there is a continuous irradiation creep due to plastic yielding, whose extent is governed by the relaxation properties of the particular structure. It is shown that in isotropic crystal structure there is only a theoretically practicable transient creep phenomenon due to climb of dislocations and clustering of defects. (auth)

37608 (A/CONF.28/P/340) DEVELOPMENT OF HEAT-RESISTANT Mg–Be ALLOYS AS A CLADDING MATERIAL FOR FUEL ELEMENTS. V. E. Ivanov, V. F. Zelenskii, S. I. Feifer, I. A. Petelguzov, and V. K. Khorenko (U.S.S.R.). May 1964. 20p.

Development of powder-metallurgy techniques for Mg–Be alloy fabrication is discussed. The alloy structure, its resistance to integrating recrystallization, and the formation of the intermetallic compound $MgBe_{13}$ are considered. Strength properties at 20 to 550°C were studied. The variation of plasticity with chemical composition, temperature, and deformation rate are covered. Corrosion resistance was investigated in air and in carbon dioxide at 470 to 580°C for 14,000 hours. Resistance to short-time overheating in the same media, and the effects of chemical composition, surface conditions, and heating rate were studied. The use of the alloys in thin-walled protective jackets on wire-type fuel elements, the jacket hermeticity and alignment with cores, and radiation effects on the jackets were considered. (M.J.T.)

37609 (A/CONF.28/P/350) STUDIES OF ELECTROLYTIC PREPARATION OF ZIRCONIUM METAL. A. N. Ogarev, D. D. Frolov, N. G. Aksenov, A. I. Nedelyaev, S. V. Golovin, V. S. Yudin, and N. F. Muchortov (U.S.S.R.). May 1964. 15p.

Sources of oxygen and nitrogen contamination of zirconium prepared in open electrolytic baths and the mechanism of their penetration into the cathode deposit were studied. Means of preventing this contamination are discussed. Data on the use of hollow cooled cathodes are given. The problem of humidity of $CaCl_2$ and K_2ZrF_6 used for electrolytes and methods of salt drying in vacuum and air at atmospheric pressure are considered. The procedure for the determination of oxygen content in K_2ZrF_6 is described. The design of the closed electrolyzer is described. (M.J.T.)

37610 (A/CONF.28/P/419) ASPECTS OF SWEDISH STUDIES OF CLADDING MATERIALS FOR WATER-COOLED REACTORS. G. Oestberg and H. P. Myers (Aktiebolaget Atomenergi, Stockholm). May 1964. 10p.

Studies of embrittlement, corrosion, and reduction of strength and ductility were carried out on zirconium-alloy and stainless-steel cladding materials for water cooled fuel elements. The research on zirconium was done for the Ågesta reactor where the operating temperature is about 250°C (pressurized water). The aim of the studies of stainless steel is to find a canning material for the Marviken superheater elements which are to produce 500°C steam. (M.J.T.)

37611 (A/CONF.28/P/444) PREPARATION AND PHYSICAL PROPERTIES OF UO_2 SINGLE CRYSTALS. P. Nagels, W. Van Lierde, R. Penninckx, et al. (Centre d'Etude l'Energie Nucleaire, Brussels). May 1964. 19p.

An extensive study of different fundamental physical properties of UO_2 single crystals of different compositions was undertaken. The different properties were studied before and after reactor irradiation. The preparation of single crystals, the variation of composition of the single crystals by controlled oxidation, sintering of single crystal spheres, transmission electron microscope observation of thin foils, and the measurement of the thermal conductivity, the electric conductivity, the thermoelectric power, the optical absorption spectrum, the elastic constants, and the resonant γ-ray absorption are included. (auth)

37612 (A/CONF.28/P/477) PROPERTIES AND TECHNOLOGY OF ZIRCONIUM ALLOYS WITH NIOBIUM AND TIN. W. Jung-Koenig (Metallgesellschaft A. G., Frankfurt am Main), H. Richter, W. Spalthoff, and E. Starke. May 1964. 18p.

The corrosion resistance of many zirconium alloys containing up to 5% niobium and up to 1.5% tin with additions of palladium, chromium, and molybdenum was investigated by exposing the specimens to 350°C water and 400 and 480°C steam. It was found that the heat treatment has a great influence on the corrosion behavior. With an appropriate heat treatment the zirconium–niobium alloys have nearly the same corrosion resistance as Zircaloy-2. The best corrosion resistance was attained by annealing below the α/β-transformation range, which was investigated by constitutional studies at (580 ± 10)°C. With the appropriate heat treatment the corrosion resistance is nearly independent of the niobium content. Annealing above 600°C causes the appearance of β_{Zr}, which has an unfavorable effect on the corrosion behavior. Tin additions have a favorable effect at 350°C, no effect at 400°C, and an unfavorable effect at 480°C. The hydrogen pick-up of niobium-containing zirconium alloys during corrosion is less than it is found in Zircaloy-2. Due to their hot strength, alloys with more than 2% niobium are superior to Zircaloy-2. An alloy with 3% niobium and 1% tin showed excellent corrosion resis-

tance and hot strength. The tin content is necessary to have a good strength at temperatures up to 450°C. This alloy was studied more intensively. A hydrogen content in the alloy $ZrNb_3Sn$ favors a martensitic structure with an increase of hardness. A hydrogen content up to 1000 ppm has no bad influence on the creep strength. Impact tests showed that hydrogen-containing and hydrogen-free samples of $ZrNb_3Sn$ are superior to the corresponding samples of Zircaloy-2. It is possible to fabricate seamless tubes of $ZrNb_3Sn$. The fabrication possibilities are discussed. The alloy may be welded by normal welding procedures, used for zirconium, but it is necessary to heat treat the welds to improve their corrosion resistance. The influence of a neutron radiation on the properties of $ZrNb_3Sn$ was tested in the Geesthacht reactor FRG 1. Samples for testing the radiation effect on the tensile and impact properties and on the structure were kept in the coolant of the reactor. Corrosion tests under irradiation were performed in heatable autoclaves within the reactor. The maximum radiation dose was 8×10^{19} nvt. The results of the radiation tests are discussed. (auth)

37613 (A/CONF.28/P/554) UO_2 FUEL ELEMENTS SHAPED AS SMALL SPHERES. F. Barbesino, E. Brutto, R. Di Pietro, A. Gioia, G. Perona, and R. Sesini (Centro Informazioni Studi Esperienze, Milan). May 1964. 10p.

Studies were made on the manufacture and characteristics of coated UO_2 spheres, 1 to 4 mm in diameter. The manufacturing process is described. The application method and autoclave testing of a Ni–Cr coating are discussed. Tests of the spheres for thermal-stress resistance and critical temperature difference are covered. No surface damage was detected in the first set of tests. An inpile technique is being studied for the measurement of fission gas release from the spheres. (M.J.T.)

37614 (A/CONF.28/P/560) REVIEW OF PROGRESS OF DEVELOPMENT, MANUFACTURE, AND PERFORMANCE OF MAGNOX FUEL ELEMENTS IN THE UNITED KINGDOM. J. C. C. Stewart (United Kingdom Atomic Energy Authority. [Production Group, Risley, Lancs], England), V. W. Eldred, T. J. Heal, D. O. Pickman, and H. Rogan. May 1964. 16p.

The progress of the provision of Magnox fuel elements for the United Kingdom Nuclear Power Program is reviewed in respect to development, manufacture, and performance. Attention is concentrated on items which can be regarded as of key importance and these are necessarily treated briefly. Various aspects of the accelerating build-up of nuclear power production in the United Kingdom toward the target of 5,000 Mw(e) by 1969 are referred to: the build-up of fuel element production at the Springfields Works of the U.K.A.E.A. in line with requirements (the Sizewell initial fuel charge is currently being manufactured); the very satisfactory behavior of the Bradwell and Berkeley stations of the Central Electricity Generating Board; and the successful commissioning of Hunterston. Reference is also made to the successful commissioning of the Latina station and to the completion of manufacture of the first charge of fuel for the Tokai Mura station. Examples of the irradiation levels reached by the various designs of Magnox fuel elements are given. (auth)

37615 (A/CONF.28/P/799) RECENT DEVELOPMENT OF BERYLLIUM STUDY IN JAPAN. K. Kida, S. Nishigaki, S. Ohashi, K. Kobayashi, and S. Mochida (NGK Insulators, Ltd., Nagoya, Japan). May 1964. 19p.

The sinterability of commercial high-purity BeO powders and CF–BeO powder was investigated, together with the properties at high temperature of hot-extruded Be from electrolyzed and hot-pressed block. The fabrication of BeO–Be and BeO–UO_2–Be sintered bodies by vacuum hot pressing was also studied. (D.C.W.)

37616 (A/CONF.28/P/843) DEVELOPMENT OF ROD AND HOLLOW-TYPE SWAGED UO_2 FUEL ELEMENTS AND SOME IRRADIATION BEHAVIORS. Shuichiro Takahashi (Mitsubishi Atomic Power Industries, Inc., Omiya, Saitama Prefecture, Japan), Yutaka Honda, Tadashi Kubota, Shozo Fujinaga, Chuko Ito, Akio Takashima, Yumi Akimoto, Takashi Suzuki, and Hidekazu Doi. May 1964. 16p.

Fabrication processes of rod and hollow type swaged UO_2 fuel elements has been developed in connection with its irradiation behaviors. As the feed, highly dense UO_2 powders were prepared by ADU-process. The precipitation of ADU under a particular condition was necessary, while for the firing in hydrogen of higher oxides (UO_3 and/or U_3O_8) relatively low temperatures of 1200 to 1750°C sufficed. The means to realize the swaging effect including close-packing and particles-bonding are small reduction in area by each pass of swaging and much pass-number in given total reduction. A swaging machine designed to have successive sets of dies tandem was used in order to enlarge the swaging effect. For cold-swaged fuel rods, the maximum density was 93% of the theoretical. Straightness was better than 0.25 mm/m. Diametral variation was within ±0.02 mm. The minimum thickness of the stainless steel sheaths of the rods swaged satisfactorily was 0.25 mm. Results of burst tests and autoclave tests on stainless steel sheaths and Zircaloy-2 sheaths of swaged UO_2 fuel rods were not inferior to as-received sheaths before swaging. Fabrication processes for hollow-type UO_2 fuel elements were to fill the annular space between the outer and inner tubes with UO_2 powder, to insert a mandrel into the hollow center, to swage the assembly, and finally to remove the mandrel. Hollow-type swaged fuel elements of 36 mm in outer diameter and 800 mm in length were fabricated without any defect in sheaths. Density of the UO_2 compact was 91 ± 0.5% of the theoretical. The maximum variation in thickness of annular layer of the UO_2 compact was within ±0.1 mm. An irradiation test of cold- and hot-swaged fuel rods was performed under the heat generation rate of 10 to 13 kw/ft and the burnup of 2700 Mwd/t–UO_2. The swaged fuel rods were highly resistive against thermal shock during the irradiation. The temperatures during the irradiation were 1300 to 1500°C at the center and 55°C at the surface. Sintering was recognized even in the UO_2 portion near the sheath, where temperature during the irradiation might not be enough to produce sintering phenomenon in the thought of normal sintering. The behavior of UO_2 fuel rods at high temperatures near or at the melting point was studied by a center line heating experiment at out-of-pile. An investigation of vibratory compaction technique using crushed UO_2 powder obtained from sintered pellets containing burnable poisons is described. (auth)

37617 (A/CONF.28/P/857) SOME ENGINEERING STUDIES CONDUCTED IN INTRODUCING BRITISH-TYPE REACTOR FOR THE TOKAI ATOMIC POWER STATION. T. Yoshioka (Japan Atomic Power Co., Tokyo), C. Asada, M. Kawasaki, R. Ueda, K. Taketani, M. Sasagawa, S. Nomura, Y. Okamoto, and S. Sato. May 1964. 15p.

The oxidation of punctured-model fuel elements and graphite blocks in atmospheres of either carbon dioxide or air was investigated at various temperatures. Experiments

were also undertaken to study the correlation of fission gas release with the extent of carbon dioxide oxidation of irradiated uranium. It was found that the amount of fission gas released during oxidation is roughly proportional to the extent of oxidation. The total amount of fission gas released throughout the oxidation period was, at 500°C, 11% of the initial fission gas content, at 600°C, 25% and at 700°C, 45%. The diffusion coefficients of Xe in the uranium oxides produced by the oxidation were also measured, and the effect of carbon dioxide decomposition on the oxidation rate of uranium was studied. High temperature creep tests were made on uranium in an attempt to study the collapse phenomenon of the fuel element. The secondary creep rates of uranium specimens were measured with a vacuum creep tester under constant loads of 2-3.5 kg/mm^2 at temperatures of 425 to 575°C. The plots of the creep rates as a function of the logarithm of the loads and of the reciprocal of the temperature were found to be linear; addition of iron or aluminum caused an increase in the creep resistance. To study neutron irradiation effects on the mechanical properties of Magnox AL 80, the dependence of the tensile strength on grain size and on the deformation rate were investigated experimentally; the results agreed with Petch's equation. Since the fuel concerned is a hollow cylinder, collapse of the fuel might occur under reactor condition. To solve this problem, a reduced model of the fuel element was subjected to carbon dioxide pressures of 30 to 50 kg/cm^2 and temperatures of 450 to 550°C and was thermally cycled between limits of ±20°C. The results showed that the change in diameter was within experimental error and 0.05 mm/month reduction under the loads of less than 30 kg/cm^2 and of 40 kg/cm^2, respectively. The heat flow characteristics of the fuel element were studied using a loop operating at 10 kg/cm^2 and at 800°C. A Magnox-clad uranium fuel was internally heated in the loop and the heat conduction characteristics and hot spot coefficient were investigated by measuring the temperature distribution of the surface. The extent of deformation and the behavior during pressure reduction were also observed. Mechanical strength tests were performed on a graphite block. (auth)

37618 (A/CONF.28/P/864) FUNDAMENTAL METALLURGICAL STUDIES FOR THE IMPROVEMENT OF METALLIC URANIUM FUEL ELEMENTS. M. R. Bastelli (Societa Nazionale Metanodotti, Milan), C. D'Amato, G. C. Giacchetti, S. Granata, R. Renzoni, F. S. Saraceno, T. B. Wilson, S. Donato, G. Piatti, and R. Theisen. May 1964. 16p.

Results of research conducted into the metallurgy of metallic uranium fuel elements are given; the study includes uranium–rich niobium alloys in the range 0.2 to 7.2 wt % Nb and the intermetallic diffusion between uranium–titanium and titanium–Magnox AL 80 couples. (auth)

37619 (AD-437260) FABRICATION AND DEFORMATION OF TUNGSTEN SINGLE CRYSTALS. Final Report. PART I. EFFECT OF BILLET ROLLING PLANE AND ROLLING DIRECTION ON THE RECRYSTALLIZATION TEMPERATURE OF SHEET FROM TUNGSTEN SINGLE CRYSTALS. A. C. Walters, R. G. Rudness, and M. Stern (Linde Co. Speedway Research Lab., Indianapolis). PART II. RECRYSTALLIZATION OF WORKED SINGLE CRYSTALS OF TUNGSTEN. W. G. Reuter, L. Raymond, and E. L. Harmon (Aeronutronic. Div. of Ford Motor Co., Newport Beach, Calif.). Aug. 28, 1963. Contract NOw-61-0671-c. 60p.

The sheet rolled from the 011(100) oriented tungsten single crystal billet had an increasingly superior recrystallization temperature over the 100(001), 100(011), and 011(011) orientations at all reductions in thickness tested in the order given. This substantiates the premise on which the study was begun that the recrystallization temperature is dependent on the initial billet rolling plane-rolling direction orientations. This dependence seems related to the slip systems available for deformation and the values of shear stress from the compressive rolling stress resolved on these slip planes. A special easy deformation mode is shown as possibly existing in those rolling orientations having the highest recrystallization temperatures in which a slip direction and rolling direction are coplanar with a force direction acting on a favorably oriented slip plane to give a high resolved shear stress and cause deformation to occur in the direction of rolling. (auth)

37620 (ANL-6703(p.536-65)) SUMMARY REPORT — INVESTIGATIONS INTO CAUSES FOR CATASTROPHIC PRE-OPERATIONAL FAILURES OF THE 80-Mw EBWR PRIMARY REBOILERS. (Memo, dated June 29, 1962 by N. Balai, J. F. Matousek, C. R. Breden, and M. Odie). (Argonne National Lab., Ill.).

The results of mechanical, corrosion, and metallographic examinations of the seamless austentic stainless steel (SS-304) reboiler tubing following the discovery of a leaking tube during the field hydrostatic tests of connected pressure piping are presented. Each reboiler unit is a conventional type U-tube bundle heat exchanger designed for vapor generation. Corrosion resistance was determined in nitric acid environments. Photomicrographs of the tubing material are shown. It was concluded that the failures were caused by poor quality tubing furnished to the fabricator, degradation of the tubing by manufacturing procedures, and use of nitric acid-containing corrosion accelerating agents. (R.E.U.)

37621 (IITRI-B6021-3) VANADIUM ALLOY STUDIES. Bimonthly Report, June 1–July 31, 1964. D. Weinstein and F. C. Holtz (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Aug. 26, 1964. Contract NOw-64-0239-c. 13p.

A vanadium alloy development program is being conducted to improve short-time creep properties at 2200 to 2400°F. The V-40Nb-30Ta-1Ti alloy presently has the best creep properties without a sacrifice of fabricability or coatability; on the basis of creep strain over a 2 hr period at 2200°F, it is an order of magnitude better than any previous vanadium alloy. Work on modification of this alloy to produce a stable, high-strength particle dispersion is continuing. (auth)

37622 (KAPL-M-6155) STRESS RELAXATION STUDIES OF HAFNIUM AND ZIRCALOY 2 AND 4. P. T. Lovejoy and G. J. Moyar (Knolls Atomic Power Lab., Schenectady, N. Y.). Apr. 24, 1964. Contract W-31-109-eng-52. 25p.

Two relatively simple relaxation tests, uniaxial tensile and cantilever beam, are developed to provide a basis for judging the adequacy of annealing treatments in relieving stresses created in nuclear reactor components during fabrication. From these tests it is concluded that an annealing temperature of 1200°F for 3 hours will result in a reduction of residual stress below 5000 psi for the following metals listed in order of resistance to stress relaxation: hafnium, beta-quenched Zircaloy, Zircaloy weld metal, and alpha-annealed Zircaloy. Relaxation tests were performed in the range 932°F to 1475°F for periods less than 5 hours. Subsequently, nominal tensile properties were determined at 600°F. Analytical methods of correcting for elastic

follow-up in the relatively "soft" tensile machine and for estimating the residual stress associated with post-annealing cantilever beam springback are presented. Cantilever relaxation tests demonstrate the same order of material ranking as the tensile relaxation tests but the overall average indicated levels of stress are lower. (auth)

37623 (USBM-RC-1122) QUARTERLY METALLURGICAL PROGRESS REPORT NO. 23, APRIL 1–JUNE 30, 1964. (Bureau of Mines. Albany Metallurgy Research Center, Ore.). Contract AT(11-1)-599. 46p.

The determination of selected properties of iron–chromium–gadolinium alloys containing 12, 18, 24, and 30 weight percent chromium and up to 5 weight percent gadolinium was completed. Recent improvements in hafnium carbide casting technology include a new mold design, which permitted the preparation of tensile bars. The essential component of the design is a segmented center section held together with iron wire. Shortly after pouring the iron wire melts, releasing the center section. This allows the casting to shrink without cracking. The determination of electrical resistivity, linear expansion, nitrogen reactivity, and shock-resistance properties of sections from hafnium carbide ingots containing free graphite to elevated temperatures was completed. Progress in the determination of the three binary phase diagrams for thorium with praseodymium, neodymium, and holmium is reviewed and data are indicated. A redirection of effort for thorium–thoria alloys is noted. Green body fabrication methods have been satisfactorily developed and progress has been made in the refinement of techniques used in the study of the subliquidus phase relationships. Efforts have centered on the examination of compositions of the UC–UO and UN–UO binary systems. The production is described of engineering quality tungsten–25 rhenium tubing. Vacuum-arc-melting and skull-casting equipment are developed, which permit production of conventional cold-mold ingots and vertical-axis centrifugal skull-castings. A method for preparation of sound, conductive consumable electrodes from blended powders of tungsten and rhenium using mechanical pressing and electron beam sintering was evolved. Melting and casting parameters were determined and both cold-mold ingots and hollow cylindrical castings were prepared for fabrication and evaluation. Two skull-cast sleeves were extruded. Sintered sleeves were processed in the following manner: screen blending powder mixtures through minus 100-mesh sieves; hydrostatic pressing at 30,000 psi; and sintering in vacuum at temperatures up to 2,900°C. Swaging attempts were made at 1,500°C with some success, but the results indicated that swaging is not a good method for initial fabrication. Two small sleeves were extruded at 1,400°C by the filled-billet technique. Two attempts to draw commercial alloy tubing at 550°C were unsuccessful. (auth)

37624 (X63-13637) EVALUATION OF SOLID PROPELLANTS AND SOLID-PROPELLANT SYSTEMS FOR SPACE APPLICATION. Seventh Quarterly Report. John M. Allen, Arthur Levy, John W. Droege, Harold E. Bigony, R. A. Markle, J. F. Kircher, I. M. Grinberg, and G. B. Shoop (Battelle Memorial Inst., Columbus, Ohio). Mar. 29, 1963. Contract NAS8-1683. 13p.

The principal emphasis was placed on obtaining additional data on the effect of prolonged vacuum exposure and gamma radiation on the PBAA and polyurethane propellants. PBAA specimens which were maintained under controlled vacuum and temperature conditions for ten months were tested for mechanical and burning properties. Similar tests were made on polyurethane specimens stored for ten weeks. Additional data on the effect of radiation on the polyurethane propellant were obtained. The results were found to be consistent with those previously reported except that the effect of radiation on the mechanical properties of the polyurethane propellant showed a dependence on the dose rate. The effects previously reported for a high dose rate were more severe than those newly encountered at a lower dose rate, for the same total radiation dose. The irradiation-vacuum exposure of igniters, igniter pellets, and case materials was completed, and an equivalent exposure of loaded one-pound motors was initiated. Crush-test results for igniter pellets, showing a moderate decrease in strength, are presented. (auth)

37625 METASTABLE PHASES AND SUPERCONDUCTORS PRODUCED BY PLASMA-JET SPRAYING. Marvin Moss, Douglas L. Smith, and R. A. Lefever (Sandia Lab., Albuquerque, N. Mex.). Appl. Phys. Letters, 5: 120-1 (Sept. 15, 1964).

The alloys Cu–Ag, Ge–Ag, and Mo–Ru were quenched from the melt at very high rates by injecting the powdered material into a high-temperature plasma and impinging the molten droplets at high velocity onto a cooled plate. In the first case, complete mutual solid solubility was obtained; the resultant alloy had fcc structure. The Ge–Ag alloy had a metastable, single-phase, hcp structure. The Mo–Ru alloy also had a hcp structure with enhanced superconductivity. (D.C.W.)

37626 ON CERTAIN PROPERTIES OF VACUUM-SILICIDED HIGH-MELTING METALS. V. E. Ivanov, E. P. Nechipochenko, V. M. Krivoruchko, and A. S. Mitrofanov (Inst. of Physics and Tech., Academy of Sciences, USSR). Fiz. Metal. i Metalloved., 17: 862-5 (June 1964). (In Russian)

Molybdenum, tantalum, and tungsten were vacuum-silicided in saturated vapors of silicon at 1200 and 1250°C, and the effect of temperature gradients on the rate of formation of the silicides of these metals was investigated. (tr-auth)

37627 STUDIES OF SUB-SCALE LAYER IN NIOBIUM AND ITS ALLOYS. N. N. Burova, S. B. Maslenkov, and G. V. Estulin (Inst. of Quality Steels at the Central Scientific-Research Inst. of Ferrous Metallurgy, [Academy of Sciences,] USSR). Fiz. Metal. i Metalloved., 17: 898-902(June 1964). (In Russian)

A study of the oxidation of niobium and of its alloys with titanium and molybdenum is described. It is found that the subscale layer on niobium and its alloys at room temperature is in the form of a solid solution of oxygen, strengthened by dispersed particles of NbO. At high temperature (1,000°C), this subscale layer in the case of pure niobium and a niobium–molybdenum alloy is in the form of a supersaturated solid solution of oxygen in niobium; in the case of titanium alloys, the lower oxides of niobium are probably present. Both the supersaturated solid solution and the lower oxides break down upon cooling of the sample, with formation of a heterogeneous mixture—a solid solution + NbO. (OTS)

37628 APPLICATION OF SHORT-LIVED RADIOISOTOPES FOR STUDIES OF FLOW CHARACTERISTICS AND MIXING PROPERTIES IN VARIOUS SYSTEMS. H. Bildstein and H. Sorantin (Inst. of Chemistry, Reactor Centre, Seibersdorf, Austria). Intern. J. Appl. Radiation Isotopes, 15: 310-12(May 1964).

A method using short-lived radioisotopes is described for predetermining the necessary increase in carrier gas flow to guarantee almost perfectly spherical coating up to high deposition rates that is essential to achieve high packing densities during the fabrication of fuel inserts. With some variations, the method used for the production of carbide fuel spheres can be used for the production of spherical particles of various refractory metals, carbides, silicides with a range of dimensions from 50 to 500 μ. After neutron activation the radiation dose of the particles can easily be calculated, if the size and specific gravity is known before irradiation. It can be checked afterwards by the specific activity of one sphere or, better, after chemical dissolution of a weighed batch and counting of the solution. (P.C.H.)

37629 METHOD FOR IMPROVING HYDROLYSIS RESISTANCE OF URANIUM CARBIDE CONTAINING COMPOSITION. J. P. Hammond and J. D. Sease (to U. S. Atomic Energy Commission). U. S. Patent 3,145,182. Aug. 18, 1964.

The present invention comprises an improved nuclear reactor fuel sintered composition having an internal structure comprising a continuous metal silicide matrix (said metal being selected from uranium, thorium, and plutonium), a carbide fuel compound (selected from uranium carbide, thorium carbide, and plutonium carbide) distributed within said matrix, and an adherent coating of said silicide integral with said internal structure. The silicide consists of at least more than 2 and no greater than about 35%, by weight, of said composition. (AEC)

Corrosion

37630 (A/CONF.28/P/63) COMPATIBILITY OF CLADDING MATERIALS WITH CARBON DIOXIDE AT HIGH TEMPERATURES. Raymond Darras and Henri Loriers (France. Commissariat à l'Energie Atomique, Paris). May 1964. 15p.

The results of tests on the resistance of Be, Be alloys, stainless steels, Al–Fe alloys, Zr, and Zr alloys to corrosion and/or oxidation in CO_2 at temperatures of 500 to 800°C and high pressures are presented. The effects of water vapor in the gas were carefully examined in the case of Be and Be alloys. It is concluded that stainless steels are still the most suitable cladding for temperatures of 600 to 700°C and high pressures. (D.C.W.)

37631 (A/CONF.28/P/157) CORROSION BEHAVIOUR OF STEELS IN CO_2/CO ATMOSPHERES. J. E. Antill (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England), C. S. Campbell, D. Goodison, W. B. Jepson, and C. G. Stevens. May 1964. 15p.

The reactions of mild, low alloy and stainless steels with CO_2/CO atmospheres have been studied in support of the development of power reactors cooled by carbon dioxide. Protective oxide films have been formed on mild and low alloy steels in CO_2 based environments at temperatures up to 550°C, although under some circumstances the films lost their protective character and the reaction rate increased markedly. Film breakdown could be postponed for a considerable time (e.g., 20,000 hr) and could be either general or localized. It was associated with temperatures >350°C, high pressures (i.e., 14.6 atm), the presence of water vapor, and to a lesser extent carbon monoxide. The behavior of a given steel was often inconsistent with respect to breakdown; no correlation could be found with steel composition although rimming steels were most susceptible to localized breakdown. A basic study of the oxidation and carburization of a 20 Cr/25Ni/Nb stainless steel [fuel element canning material for the Advanced Gas Cooled Reactor at Windscale (WAGR)] has been carried out in pure CO_2, CO, and mixtures of these gases at 600–850°C. Thin protective oxide films were formed in all instances. Carbon transferred from the gas phase during film growth readily passed through the oxide into the steel while carbon deposited on the surface of a preformed oxide film diffused only slowly during a subsequent anneal in an inert atmosphere. The penetration of the carbon into the steel was determined and at temperatures ≥750°C a maximum up to 75μ from the oxide/metal interface was found in the carbon concentration-penetration curve. The oxidation of WAGR fuel element cans has been studied under simulated reactor operation and fault conditions involving a temperature excursion and ingress of steam and air into the coolant circuit. The behavior was satisfactory for protracted periods in CO_2 up to 750°C, but at higher temperatures loss of fin profile occurred which could adversely affect the heat transfer properties of the cans. The behavior was not significantly affected by total pressure of additions of CO, H_2O, or air to the gas. (auth)

37632 (A/CONF.28/P/341) CORROSION RESISTANCE OF ZIRCONIUM AND ITS ALLOYS IN WATER AND STEAM AT HIGH TEMPERATURES. V. S. Emelyanov, A. I. Evstyukhin, G. B. Fedorov, G. G. Ryabova, N. V. Borkov, I. I. Korobkov, and P. L. Gruzin (U.S.S.R.). May 1964. 19p.

Corrosion resistance of zirconium and its alloys depends on the distribution of the components along the grain boundaries and resulting oxide films. Contact autoradiography and metallography show that carbon, hydrogen, nitrogen, and some alloying impurities such as tin, iron, nickel, and niobium affect zirconium corrosion resistance in water and steam. In one study, radioisotopes were added to zirconium during the alloying process. The samples underwent a heat treatment and then the corrosion-resistance test. Redistribution of the alloying components during corrosion in inactive water and high-parameter steam was analyzed. In a second study, inactive zirconium alloys corroded in tritium-containing steam and water were analyzed. Electron microscope studies were made of corroded surfaces of zirconium and alloys and of their cross sections subjected to cathode pickling. (M.J.T.)

37633 (A/CONF.28/P/342) INFLUENCE OF SOME FACTORS UPON HYDRIDING AND VARIATION OF PROPERTIES OF ZIRCONIUM ALLOY WITH 1% Nb USED FOR FUEL ELEMENT CLADDING IN WATER-MODERATED WATER-COOLED POWER REACTORS. A. D. Amaev, R. S. Ambartsumyan, A. A. Kiselev, et al. (U.S.S.R.). May 1964. 20p.

Data on studies carried out with the zirconium jackets of heat-producing elements and various zirconium-alloy specimens tested in experimental water loops of a physical and chemical research reactor are presented. It was established that the degree of hydriding and the disposal of hydrides depend on the conditions under which the heat-producing elements operate. It was shown that the nature of disposal of hydrides in the jackets of the heat-producing elements varies with the increase of heat loads. At low heat loads, hydrides are oriented along the generatrix, while at high heat loads they are disposed in the main

radially. In addition, migration of hydrides toward the cooler side of the jacket was observed. Effects of stresses on the nature of the disposal of hydrides, which are formed due to corrosion in water, were studied with a nonradioactive tubular specimen. It was found that with the greater stresses the number of radially disposed hydrides increases and that such a disposal of hydrides results in a sharp reduction of the mechanical strength of the jacket material. In a physical and chemical research reactor an experimental assembly of heat-producing elements with pre-hydrided zirconium-alloy jacket was tested. The assembly operated successfully at a heat load of 1×10^6 cal/m^2·hr. The results of detailed study of the jackets of the heat-producing elements of this assembly are presented. The results are also described of the study of the mechanical properties and of the nature of disposal of hydrides in zirconium-alloy specimen pre-hydrided to a different degree and exposed to radiation together with this assembly of heat-producing elements. Specimens of the same series exposed to radiation in a "dry" channel were taken as references. It was found that in the specimen exposed to radiation in a non-strained state in water to a temperature of 290°C and known to have a uniform distribution of hydrides, the change of mechanical properties at a flux of 10^{12} n/cm^2 accounted in the main for the radiation. It was proved furthermore that a greater susceptibility of the specimen to notching results from prehydridation. Radiation results in a higher sensitivity of alloys to notching. Investigations that were carried out showed that despite some reduction in mechanical properties, heat-producing elements with zirconium-niobium alloy jackets can be advantageously used in water-moderated, water-cooled reactors. (auth)

37634 (A/CONF.28/P/343) CORROSION RESISTANCE OF CONSTRUCTIONAL MATERIALS IN ALKALI METALS. B. A. Nevsorov, V. V. Zotov, G. P. Fedortsev, et al. (U.S.S.R.). May 1964. 18p.

Experimental results from studies of high-temperature corrosion resistance in alkali metals under static and dynamic conditions are given. The tendency of some heat-resisting steels and alloys to mass transfer in a non-isothermal sodium flow is plotted, data on molybdenum and niobium corrosion as a function of oxygen content in sodium are given, experimental results of a carbon transfer-mechanism study in sodium are described, and data on corrosion of construction materials in lithium are given. (M.J.T.)

37635 (A/CONF.28/P.445) CORROSION OF REACTOR MATERIALS. M. J. Brabers (Centre d'Etude l'Energie Nucleaire, Brussels), G. Mestdagh, J. Meunier, G. Spaepen, and P. Weisgerber. May 1964. 14p.

An electrochemical study of the effect of irradiation on the corrosion of some reactor materials is described. Corrosion experiments on aluminum, zirconium, titanium, niobium, Zircaloy-2, stainless steel, and platinum were carried out in-pile, and after pile irradiation, and the results were compared with those obtained out-of-pile under identical conditions. Electrochemical techniques were applied as testing method. The influence of surface treatment on the behavior of carbon steels and stainless steels in water and steam at high temperature was also investigated. (auth)

37636 (A/CONF.28/P/574) ZIRCALOY-2 PRESSURE TUBES CORROSION. F. Barbesino, E. Brutto, R. Di Pietro, G. Masini, G. Perona, and R. Sesini (Centro Informazioni Studi Esperienze, Milan). May 1964. 16p.

The corrosion of Zircaloy-2 tubes by steam–water mixture flows was investigated. An observed acceleration of the corrosion rate under dynamic conditions was attributed to the stress due to the pressure difference between the inner and outer surfaces of the samples. Oxide films obtained under both normal and stress conditions were also examined by electron microscopy and measurements of electrical properties. (D.C.W.)

37637 (A/CONF.28/P/591) IMPROVED ALUMINIUM ALLOYS AS FUEL CLADDING MATERIAL IN WATER COOLED POWER REACTORS. Steinar Aas and Ketil Videm (Norway. Institutt for Atomenergi, Kjeller). May 1964. 17p.

Aluminum cladding material can reduce the fuel cost in a boiling heavy-water reactor by 0.1 to 0.4 mills/kwh depending upon wall thickness, enrichment, and other factors. Extensive loop testing of aluminum alloys of nominal composition Al–10 wt % Si, 1 wt % Mg, and 1 wt % Ni at 265 and 315°C has shown that the alloys have a general corrosion rate of 0.03 mm/year. This low rate makes these alloys readily applicable in water-cooled power reactors. Creep tests at elevated temperatures show that the 10% Si, 1% Mg alloys have appreciably better mechanical properties than 2 S or X8001. The creep strength is nevertheless not good enough to make the cladding-tube free-standing. The metal will consequently contract and expand according to the movement of the fuel. These strains may lead to fatigue failure; results from strain-fatigue tests are given. These show that the alloy will have a satisfactory life time. The cladding tube may also fail because of ratcheting or similar phenomena; these problems are reviewed. The assembly of fuel stringers with long non-free standing cladding tubes presents some difficulties and some experimental designs are shown. One of these is presently being tested at 315°C in an out-pile-loop. Elements of a similar design are being made for testing in the Halden Boiling Water Reactor in the very near future. (auth)

37638 (A/CONF.28/P/592) MILD STEEL IN PRIMARY CIRCUITS OF WATER COOLED POWER REACTORS. Ketil Videm (Norway. Institutt for Atomenergi, Kjeller). May 1964. 15p.

The corrosion and purification problems in a mild steel system were investigated, considering a direct-cycle boiling-water reactor as a reference. A series of corrosion experiments in out-of-pile loops were performed both at high and low temperatures. The results were compared with the literature and with corrosion experiments carried out in a boiling water power reactor. The effect of the oxygen content and pH and methods for preconditioning of the steels in order to minimize the corrosion and corrosion product release especially were considered. It was concluded that the high temperature corrosion resistance of normal boiler steel in boiling water reactor environment is acceptable and that corrosion of components at low temperature and attack during shutdown on parts normally at high temperatures are the problems most difficult to handle. In all circumstances the application of carbon steel or low alloy steels will result in more corrosion products being given off to the water, and a more effective purification system is required. (auth)

37639 (EURAEC-1130) IN-PILE CORROSION OF NUCLEAR MATERIALS. Quarterly Report No. 8, January 1–March 31, 1964. (Centre d'Etude de l'Energie Nucleaire, Mol, Belgium). Work Performed under United States–Euratom Joint Research and Development Program. Contract 084-64-3/RDB. 11p. (R-2284)

Pitting was studied on steel 304 and 304 L by means of potentiodynamic measurements. The electrolyte solution was either a solution of pure KCl or 10 g $KHCO_3$ + 10 g KCl per liter. The pitting was characterized by the potential E_p at which an increase in electric current occurs at rising potential. The effect of irradiation of solution and both metal and solution was studied separately. The results show that in general the pitting potential E_p is lowered by irradiation of the solution alone. The absolute value of this pitting potential, however, depends strongly on factors such as mechanical and electrolytic polishing, depassivation, and cathodic prepolarization. When the surface of the steel is activated the decrease in pitting potential by irradiation of the solution is consistently found; when the surface is passivated, effect of irradiation may be less. Foils of zirconium, Zircaloy-2, niobium, and titanium were irradiated in argon–oxygen atmospheres and the oxide characteristics measured. During pile irradiation at 25°C the oxide thickness increases, and the change in thickness increases with increasing exposure time. (auth)

37640 (HW-75359) THE GALLING OR SCRATCHING OF THE NPR OUTER FUEL ELEMENT BY THE INNER FUEL ELEMENT SUPPORTS. Interim Report. R. K. Robinson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 23, 1962. Contract AT(45-1)-1350. 25p.

Evaluation of the corrosion behavior of scratches and the gray oxide produced thereby in the bore of the NPR fuel element during assembly is about one-half completed. Micrographic examination of the scratches, produced by sliding inner fuel elements with buggy spring supports oversized 10, 20, and 30 mils per support through outer fuel elements, indicated scratch depths of 0.2 to 0.7 mils. Examination of the scratched areas after 6, 30, and 66 days in 400°C steam and 30 days in 360°C water resulted in corrosion product thickness ranging from 0.1 to 0.6 mils or from 1 to $2\frac{1}{2}$ times the thickness of the oxide over the bulk metal. For all but two coupons, exhibiting unexplained anomalous corrosion behavior, the amount of hydrogen pick-up (15 to 40% of theoretical amount available) and thickness of corrosion product compares favorably with that of "good" Zircaloy-2 exposed to the same media. Exposure to 400°C steam and 360°C water is continuing for 10, 20, 30, and 60 mil interference fit per support samples. (auth)

37641 OXIDATION OF GADOLINIUM IN THE TEMPERATURE RANGE 500-700°C. S. A. D'Souza, H. B. Mathur, and A. B. Biswas (National Chemical Lab., Poona, India). Indian J. Chem., 2: 307-11(Aug. 1964).

The oxidation of gadolinium metal in oxygen was studied in the temperature range 500-700°C. The oxidation is governed by a mixed parabolic-linear equation, $X^2/K_p + X/K_L = t$ where K_p and K_L are the rate constants for the parabolic and linear equations respectively, and the first term (X^2/K_p) corresponds to ionic diffusion through the oxide film, the activation energy for which is 54 kcal/mole, and the second term (X/K_L) to a reaction at the oxide/oxygen interface. Experiments with radioactive markers show that oxidation takes place by oxygen ion diffusion through anion vacancies in the oxide layer. (auth)

37642 THE OXIDATION OF PYROLYTIC GRAPHITE AT TEMPERATURES OF 1400°-1800°F AND AT AIR VELOCITIES OF 25-100 cm/sec. Milton Levy and Philip Wong (Army Materials Research Agency, Watertown, Mass.). J. Electrochem. Soc., 111: 1088-91(Sept. 1964).

A gravimetric study was made on the oxidation kinetics of pyrolytic graphite between 1400 and 1800°F at air velocities of 25-100 cm/sec and atmospheric pressure. The anisotropic behavior of pyrolytic graphite as reflected in its oxidation behavior was also studied. Generally the oxidation may be considered to proceed in two stages. The first stage represents the time necessary for the graphite to reach a relatively uniform oxidation temperature, approximately 5 min. The second stage is characterized by the most constant temperature, although there is a relatively slight increase in oxidation rate with increasing time (probably due to a gradual increase in surface area). A large increase in the rate of oxidation occurs between 1500 and 1600°F and 50 cm/sec air velocity. Similar results were obtained for air velocities of 25, 75, and 100 cm/sec. A major change in the mechanism occurs in this region, which suggests a transition from chemical to diffusion control. (P.C.H.)

37643 CATASTROPHIC OXIDATION OF BERYLLIUM METAL. G. Ervin, Jr., and T. L. MacKay (Atomics International, Canoga Park, Calif.). J. Nucl. Mater., 12: 30-9 (May-June 1964).

Beryllium oxidation in dry oxygen was studied over the temperature range, 500–900°C. Microscopic observations of oxidized surfaces revealed that pits develop in the metal under the thin, adherent oxide film during the initial protective period of the oxidation and that these pits weaken and undermine the metal surface until metal fracture occurs. At this point there is an acceleration in oxidation rate caused by exposure of increased metal surface to oxygen, and the specimen surface disintegrates to produce a mixture of metal and oxide powder. It was found that during the protective period, the rate was parabolic, and the rate constants varied with a fractional power of the oxygen pressure, in approximate agreement with the result predicted by the assumption that diffusion of beryllium ion vacancies in the oxide film lattice controls the oxidation rate. Pitting is attributed to dislocations in the metal and pits are presumed to occur at the points of emergence of dislocation lines to the metal surface. Fracture of the metal surface is attributed to brittle failure of the pitted surface as a result of stresses imparted by the growing oxide. (auth)

37644 THE EFFECT OF COMPOSITION OF ZIRCALOY ON ITS CORROSION RESISTANCE IN HIGH TEMPERATURE WATER. G. Ito and R. Hashiguchi. Trans. Natl. Res. Inst. Metals (Tokyo), 5: 115-19(Aug. 1963).

Studies were made on the corrosion resistance of Zircaloy in high temperature water using the domestic-made sponge of zirconium as a raw material. The composition of the sponge made in Japan is given; its most remarkable feature is that the nitrogen and carbon contents, which affect corrosion resistance of the alloy, are less than that of foreign makes. It was revealed from the results of corrosion tests conducted in high-purity water at the temperature of 320°C that the Zircaloy having the composition of 0.8–1.2% Sn, 0.15–0.20% Fe, 0.10–0.15% Cr, and <0.05% Ni showed better corrosion resistance than that of Zircaloy-2. (Atom Dokumentation, Vol. 6, No. 11, June 1964)

Fabrication

Refer also to abstracts 37409, 38602, and 38628.

37645 (A/CONF.28/P/57) THE MANUFACTURE OF FUEL ELEMENTS IN FRANCE. Roger Boussard (Com-

missariat à l'Energie Atomique, Paris), Bernard Boudouresques, and Jean Nadal. May 1964. 17p.

The industrial manufacture of fuel elements of the natural uranium metal–magnesium alloy-clad type for graphite-moderated, gas-cooled power reactors is discussed. Problems involved in the fabrication of enriched uranium–aluminum-clad fuel elements for pool-type reactors are reviewed. (auth)

37646 (A/CONF.28/P/151) DEVELOPMENT OF A LARGE-SCALE MANUFACTURING PROCESS AND PLANT FOR PLUTONIUM FAST REACTOR FUEL. S. E. Smith (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England); J. S. Broadley, F. Brown, and W. C. L. Kent. May 1964. 14p.

The development work from which future large scale plants for the production of plutonium fast reactor fuel elements in the U.K. will be designed is discussed. The purpose of the plant required may be divided into three categories: (a) raw fuel material production, (b) manufacture of fuel into a compacted form, and (c) fabrication of fuel elements. Consideration of the special requirements of criticality, shielding, containment, and active maintenance, as applied to a large scale production facility, leads to the conception of continuous operation using safe by shape linked equipment for the bulk fuel, sections (a) and (b), and of a production line largely influenced by pin movement considerations, for section (c). The development for each of these sections is proceeding by way of inactive and uranium based equipment studies in the first instance, leading to initial versions of plant suitable for use with plutonium, and finally to a full demonstration of the plant and containment on a scale giving approximately the output required to support the prototype fast reactor. The first section of the plant is based on the preparation of mixed Pu/U oxides by continuous coprecipitation from solution with ammonia, using a novel multistage precipitation technique, the chemistry and theory of which are described. The product is continuously filtered, washed, and dried and then subjected to calcination, reduction, and surface area adjustment in a single stage. The resulting oxide powder possessing the requisite homogeneity, is then converted into a compacted form in a continuous granulation plant, which includes a novel spheroidization process. This forms the feed for either a pelleted or a vibro-compacted fuel product. Should carbide be required, it is possible to add to this system, equipment for the oxide/carbon reduction process, and thus the fuel production plant is being developed on very flexible lines. After sintering to high density the fuel is loaded into cans and plant development is concerned largely with the layout of a system for transferring fuel pins of awkward shape along a series of consecutive loading, sealing, welding, etc. operations at a reasonable production rate. (auth)

37647 (A/CONF.28/P/336) URANIUM PREPARED BY POWDER METALLURGY TECHNIQUES. G. A. Meerson, G. P. Kurbatov, Ya. D. Pakhomov, G. N. Kalinin, E. V. Ryabin, and G. L. Zverev (U.S.S.R.). May 1964. 19p.

Investigations carried out on a metal obtained by hot pressing uranium powder are described. Essentially nonporous billets were produced by hot pressing in stainless steel dies. High stability of the metal to cyclic changes of temperature results from the fine-grained, quasi-isotropic structure of the hot-pressed metal. The variation in the conditions of the thermomechanical treatment of hot-pressed billets results in a change of their structure, eliminates the embrittling effect of oxide film inclusions, and permits variations of the properties of a dense metal in a wide range. The effects of the amount of the flux ($CaCl_2$) in the charge (UO_2 + Ca) on the uranium powder particle size distribution, as well as the powder particle shapes, the metal structure, the character of the oxide inclusion distribution and the properties of uranium prepared by the powder metallurgy technique as a function of the thermomechanical treatment conditions are shown. (auth)

37648 (A/CONF.28/P/351) THE TECHNOLOGY OF REACTOR CONSTRUCTION FABRICATION OF METAL BERYLLIUM AND ITS OXIDE. B. G. Ignatiev, L. A. Ishvanov, N. I. Poltoratsky, V. N. Stepanov, A. K. Savenko, N. F. Mironov, P. L. Volodin, and M. I. Tumbakova (U.S.S.R.). May 1964. 20p.

Fabrication technology for metallic Be reflectors and moderators and beryllium oxide reflectors for research reactors is described. A Be distillation plant and distilled Be milling are discussed. Shaping compact metal-ceramic slabs, cold pressing with subsequent sintering, and hot pressing methods are considered. A description of pressure casting on a thermoplastic binder of slips of beryllium oxide and conditions for removing the thermoplastic binder from castings are given. High-temperature sintering of details in a flame furnace is described. Principles of mechanical treatment of beryllium oxide details on a flat grinding machine by coherent and free abrasive are stated. (M.J.T.)

37649 (A/CONF.28/P/432) DEVELOPMENT OF BONDING METHODS FOR GRAPHITE MATERIALS. Yoshio Ando (Tokyo Univ.), Tadato Fujimura, Mitsuo Nomaguchi, and Yoshihiko Inoue. May 1964. 12p.

A brazing material (Ni–Fe–Ti alloy) for graphite that allows brazing temperatures of 1300 to 1600°C, so that the the brazed graphite joints are serviceable at temperatures of 700 to 1000°C is reported. Tested for long periods at elevated temperature, a bond showed no indication of carbide formation to embrittle the bond. Another form of the same brazing material developed is a paste obtained by mixing the metals in powdered state, using an organic compound such as styrene for binder. The advantage of this paste is the possibility of obtaining different kinds of composition to suit particular purposes, thus providing a very versatile brazing material. The binder decomposes by heat during brazing, but leaves little residual carbon, and being free of oxygen in its molecular structure, it does not affect the bond. The development of vacuum brazing, inert-gas-shielded arc brazing (Tig brazing), and resistance brazing methods is reported. Other new techniques developed include reinforcement with metallic deposit beads and double-pass Tig brazing. The bonding of metallic terminals on SiC electric heaters is reported. SiC is a good heater material for in-pile experiments since it can provide high temperatures and high power density, at the same time permitting the use of a high-voltage and low-current system. SiC heater terminals have in the past been fixed mechanically, which limited the temperature at terminal to 200°C. A new process was found by which titanium terminals can be bonded to SiC heaters with graphite as interspacer. The terminals fixed by this process are capable of withstanding 1000°C. (auth)

37650 (A/CONF.28/P/486) EXPERIMENTAL STUDIES ON THE FABRICATION OF THIN FUEL PLATES WITH U_3O_8–Al CERMETS. T. D. de Souza Santos, H. M. Haydt, and C. T. de Freitas (São Paulo, Brazil. Universidade. Instituto de Energia Atômica). May 1964. 15p.

The fabrication of 0.7-mm-thick fuel plates completely clad with aluminum alloy by roll bonding of picture frame sets with a cermet inside the frame component and by cast cladding of the cermet was investigated, using cermets with 40 to 60% U_3O_8 dispersed with aluminum powder. The plates obtained were homogeneous, and corrosion tests performed at 70°C over 100 hr in deionized water revealed no unexpected abnormalities. (D.C.W.)

37651 (A/CONF.28/P/493) FUEL ELEMENT PRODUCTION AT THE JEN. J. D. Pedregal, H. Bergua, J. Díaz, A. D. Beltrán, and E. Aparicio (Spain. Junta de Energía Nuclear, Madrid). May 1964. 14p.

The main lines of effort at the Metallurgy Division of the J.E.N. are described. As far as core materials are concerned metallic uranium, uranium dioxide, and uranium monocarbide production techniques were developed. There is also small group working on the fabrication of aluminum clad fuel plates for the J.E.N. research reactors of Argonaut and swimming pool type. (auth)

37652 (A/CONF.28/P/526) DIFFUSION BONDING OF URANIUM WITH MAGNESIUM BY MEANS OF INTERMEDIATE LAYERS. Vladimir Kraus (Ceskoslovenska Akademie Ved. Ustav Jaderneho Vyzhumu, Rez). May 1964. 18p.

Due to mutual solid state immiscibility of uranium and magnesium the bonding of these metals without a high joint deformation is impossible. However, samples of uranium–interlayer–magnesium were welded by diffusion at a constant initial compression and at various temperatures and times of annealing. The weld quality was investigated by measuring the sliding weld strength and by the methods of optical metallography. The strength of the U–Zr–Mg weld at a temperature of 500°C attained approximately 45 kg/cm^2. An aluminum interlayer of a thickness of 8μ reacts throughout with uranium sooner than any considerable interaction with magnesium takes place. The welds produced in this way showed a sliding strength of nearly 500 kg/cm^2, which did not change with a long-time heating. The strength at 500°C attained in this case values up to 70 kg/cm^2. The characteristics of uranium welds with magnesium using nickel and copper intermediate layers are very similar. At a short-time diffusion heating below the eutectic temperature (507°C for the Ni–Mg system and 485°C for that of Cu–Mg) diffusion layers were obtained with a sliding strength of approximately 200 kg/cm^2. The experiments made have proved the dependence of the bond strength on temperature and time of diffusion treatment. Assuming the bond strength dependence on the diffusion transfer of a certain amount of mass necessary for forming a cohesive intermediate region between the joined crystal lattices a relation was derived which describes the time-temperature dependence of the bond strength. (auth)

37653 (A/CONF.28/P/555) THE PREPARATION OF DENSE PARTICLES OF THORIUM AND URANIUM OXIDE. G. Cogliati, R. De Leone, G. R. Guidotti, R. Lanz, L. Lorenzini, E. Mezi, and G. Scibona (Italy. Comitato Nazionale per l'Energia Nucleare, Rome). May 1964. 19p.

A method for the preparation of dense thorium and uranium oxide particles which does not require the use of high temperatures, except for the final firing step, was investigated. The method was based on the trend of thorium and uranium salts to form spatial micromolecules when in very concentrated solutions and in highly acid-deficient conditions. Depending on the water content, the anion/cation molar ratio, and the preparation process, a product ranging from a colloidal suspension to a more or less fluid glassy gel is obtained. In the step of a very fluid gel, the product can be shaped (in the form of small spheres, for instance), and consolidated by further water or anion withdrawal and/or by a partial satisfaction of the remaining anions. Lastly, upon firing, dense particles with peculiar features are obtained (for instance the thorium oxide particles look transparent under the optical microscope). Details regarding a method of producing concentrated uranium(IV) nitrate solutions (which can be one of the starting products), their stability against oxidation, and the analytical control methods are supplied. The preparation and control methods for the fluid gels to be shaped are briefly reported. The shaping of the spherical particles and the most important properties of the fired final products are outlined. (auth)

37654 (A/CONF.28/P/634) PREPARATION OF UO_2 AND ThO_2 POWDERS IN THE SUBSIEVE RANGE. M. E. A. Hermans and H. S. G. Slooten (Keuring van Electrotechnische Materialen, N. V., Arnhem, Netherlands). May 1964. 16p.

The specifications to be met include: mean diameters varying from 4 to 10 μ, small standard deviation, low specific surface area, and smooth and preferably spherical surfaces. Moreover, the process should be of the once-through type (no recycle). Three processes were developed that could meet the above mentioned requirements. It was shown, however, that the particle size could easily be varied, with the result that the processes can also be adapted to other requirements. Moreover it would seem that the processes are well suited to remote control and thus might be preferably used for the refabrication of fuel after reprocessing. (auth)

37655 (A/CONF.28/P/700) CERAMIC FUEL OBTAINED BY METALLIC-GRADE UO_2 POWDER. D. S. Jovanovic, E. M. Kostic, I. G. Momcilovic, V. J. Petrovic, and M. M. Ristic (Institut za Nuklearne Nauke "Boris Kidric," Belgrade). May 1964. 14p.

Ceramic fuel containing sintered uranium dioxide is normally obtained from "ceramic grade" UO_2 powder. Our trends have been directed toward obtaining this fuel from the "metallic grade" UO_2 powder, although this method is unusual. The characteristics of uranium dioxide powder have been therefore determined by sedimentation analysis and at the same time the influence of flocculation on the values of characteristic parameters of the powder observed. It has been attempted to define a parameter characterizing the powder which is independent of experimental conditions. In accordance with our earlier theoretical and experimental work it has been shown that this characteristic value can be also found in this particular case. The weight mean diameter of uranium dioxide is linearly dependent on concentration and can be extrapolated to zero from which the characteristic parameter of the powder is defined. An analysis of the experimental results also indicates that orthokinetic flocculation of the uranium dioxide investigated is not particularly pronounced in some metal powders. Investigations of the "metallic grade" uranium dioxide powder by the differential thermal analysis method have shown that its fraction below 60 microns has a characteristic temperature difference of 158°. This indicates that it belongs to the group of sinterable powders which have been proved

by simultaneous investigations of the sintering of "metallic grade" uranium dioxide powder prior to fractionation and of the separated fraction. By sintering the "metallic grade" uranium dioxide powder whose agglomerates are below 60 microns in an atmosphere of water vapor or carbon dioxide at 1300° densities up to 96% of theoretical values can be obtained. This indicates that high density sintered fuels can be easily obtained from "metallic grade" uranium. The characteristic fracture through grains and the adequate grain size have been observed by fracture surface and microscopic studies. (auth)

37656 (A/CONF.28/P/733) CONTRIBUTION TO THE STUDIES OF THE TECHNOLOGY OF Al–Al_2O_3 COMPOUNDS WITH REGARD TO NUCLEAR APPLICATION. D. Gualandi (Istituto Sperimentale Metalli Leggeri, Novara, Italy) and P. Jehenson. May 1964. 20p.

The fabrication procedures and the main properties of Al–Al_2O_3 compacts (SAP) are outlined. Oxide content, impurities, homogeneity, and mechanical properties were discussed. (auth)

37657 (A/CONF.28/P/751) FABRICATION OF URANIUM OXIDE FUEL ELEMENTS AT TROMBAY. S. Fareeduddin, R. K. Garg, U. C. Gupta, S. K. Kantan, R. Rajendran, N. K. Rao, K. K. Sinha, G. V. S. R. K. Somayajulu, and K. Subramanian (India. Atomic Energy Establishment, Trombay). May 1964. 19p.

A 19-rod cluster type of fuel element has been chosen for the proposed prototype power reactor NUHMOC from considerations of high specific power. The present fuel elements were fabricated for studying the physics parameters in the zero energy reactor, ZERLINA. The fabrication of the 19-rod fuel clusters starting from the production of ceramic grade uranium oxide powder is described. The uranium oxide has been prepared under different conditions, using gaseous or liquor ammonia or other reagents for precipitation, and by varying the conditions of calcination and reduction. The conditioning of the powder to minimize its pyrophoric tendency and to achieve a desirable O/U ratio has been studied. The effect of the physical characteristics of the powder such as particle size, specific surface, bulk and tap densities on the ultimate sintered densities has been investigated. The various steps involved in the fabrication of the uranium oxide pellets such as granulation, blending, compacting, dewaxing, and sintering have been dealt with. The effect of die taper in die design, pressing conditions, the effect of various atmospheres, such as vacuum, carbon dioxide and nitrogen, during dewaxing have been studied. Similarly the conditions of sintering have been varied to achieve high sintered densities at as low a sintering temperature as possible. The sintered pellets are centerless and surface ground prior to assembly and these aspects have been briefly discussed. The assembly of the machined uranium oxide pellets into 1S-aluminum tubes (14.4 mm ID, 0.7 mm wall thickness, and 2429 mm long), the end-closure by argon arc fusion welding, and their assembly into 19-rod clusters are described. A complete charge of the fuel loading for test purposes on Zerlina will be ready by the middle of 1964. (auth)

37658 (A/CONF.28/P/832) FABRICATION OF FUSED UO_2, UC FEED MATERIAL AND CAST UC RODS. P. Himmelstein, W. Hoppe, B. Liebmann, L. Schaefer, L. Schikarski, and W. in der Schmitten (Nuklear-Chemie und -Metallurgie G.m.b.H., Wolfgang bei Hanau am Main, Germany). May 1964. 16p.

Development work on swaging and vibrational compaction of UO_2 and on the fabrication of UC feed material and cast rods is described. A new technique for producing fused UO_2 suitable for vibrational compaction is discussed. Research results on preparing stoichiometric UC and on casting UC in a centrifugal casting furnace are briefly summarized. A description of a production line for the manufacturing of 4.4 tons of cast UC rods and the experience gained during the production are presented in detail. (auth)

37659 (A/CONF.28/P/837) FABRICATION OF FUEL ELEMENTS FOR RESEARCH REACTORS. Carlos Araoz, Carlos A. Martinez Vidal, Jorge Mazza, Rino Morando, and Oscar Wortman (Argentina. Comisión Nacional de Energía Atómica, Buenos Aires). May 1964. 15p.

Fuel-element fabrication for the RAEP, an experimental reactor for radioisotope production, with maximum power 5 Mw, water coolant, 90% enriched U fuel, and MTR-type fuel elements, is described. The processing of the Al–U alloy for the core and the picture-frame manufacturing method are considered. The manufacture of a fuel element for the reloading of the RA-1 reactor is discussed. The core element is cylindrical, Al-clad, of C and 19.7% enriched UO_2. The core is made by hot extrusion of a powder mixture and vacuum degassing. The manufacture of a cylindrical fuel element with a U_3O_8 core and Al cladding, obtained by co-extrusion is described. (M.J.T.)

37660 (ANL-6876) THE FEASIBILITY OF CENTRIFUGAL CASTING FOR MANUFACTURING MASURCA ELEMENTS. R. L. Lesser and J. E. Ayer (Argonne National Lab., Ill.). May 1964. Contract W-31-109-eng-38. 10p.

Experiments were performed to establish the feasibility of manufacturing Masurca elements by centrifugal casting U–25 wt % Pu–1.5 wt % Fe alloy into thin-walled, stainless steel jackets. This process simplifies the fabrication of jacketed elements and reduces the number of steps required to fabricate the fuel element. One casting was made with U–6 wt % Fe alloy, two others with the plutonium alloy. One plutonium alloy element was finished after casting. The process appears practical. The jackets were not attacked by the plutonium alloy and no bonding occurred. (auth)

37661 (ASD-TDR-63-799(Pt.I)) JOINING OF REFRACTORY METAL FOILS. J. W. Welty, P. J. Valdez, C. E. Smeltzer, Jr., and C. P. Davis (Solar, San Diego, Calif.). July 1963. Contract AF33(657)-9442. 210p. (AD-424651)

Standard methods of welding and brazing refractory metal foils (D36, B66, and TZM) are presented. Electron beam, tungsten inert gas, resistance, and ultrasonic welding techniques are evaluated. Nine selected candidate brazing alloys for these materials were screened by means of T-joint brazements, room temperature, high temperature mechanical property tests, and metallographic structure examination. The most promising joining methods for these materials were extended to the fabrication of small honeycomb panels (0.002-inch core, 0.010-inch face sheets) which were block-shear tested at temperatures between 2000 and 2800°F. (auth)

37662 (BNL-874(p.10-11)) NEUTRON TRANSMUTATION DOPING OF SEMICONDUCTORS. Carl N. Klahr (Fundamental Methods Associates, Inc., New York).

Progress in the development of a process for fabricating semiconductor devices and microcircuits by neutron transmutation doping is described. The progress involves the

insertion of electronically active impurities in silicon and germanium in a controlled spatial pattern by reactor irradiation of semiconductor blanks, enclosed in a radiation die with a predetermined slit pattern. Radiation dies of Cd have been fabricated by several processes and have been used successfully. (P.C.H.)

37663 (NAA-SR-9604) PROCESS DEVELOPMENT FOR BONDING ZIRCALOY 2 CLADDING TO GRAPHITE MODERATOR. S. K. Lee (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 1, 1964. Contract AT-11-1-GEN-8. 62p.

A process, utilizing copper as an agent to braze Zircaloy-2 and graphite, was developed as a means of stabilizing Advanced Sodium Graphite Reactor (ASGR) moderator cans. The process consists of plasma spraying a controlled amount of copper on the Zircaloy-2, and holding the coated surface in firm contact with graphite. Upon heating above the Zr–Cu eutectic temperature, a molten Zr–Cu alloy forms, which bonds the Zircaloy 2 and graphite together. Bond strength and high-temperature stability were determined by mechanical tests, thermal cycling tests, and high-temperature exposure tests. The effects of the bonding process on the mechanical properties of Zircaloy-2 were also evaluated. Thermal analysis indicated that both furnace and radiant zone heating would meet the bonding process requirements. However, test components, simulating the moderator can geometry, bonded by these two techniques did not achieve full bond coverage. Leaks in brazing retorts, which occurred during the bonding processes, and loose fit-up of test parts, were the main factors contributing to this lack of full bond coverage. It is believed that bonding of the full-size Zircaloy-2 moderator can is feasible. More development work will be required to implement the bonding process requirements on a reliable production basis. (auth)

37664 (NAA-SR-Memo-9221) EROSION OF TEST SAMPLES DURING ELECTRIC WELDING. A. T. Stell (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 25, 1963. Contract AT-11-1-GEN-8. 19p.

Maxwell's equations of electrodynamics and the heat equations are solved in the region of interest. The results show good agreement with temperature readings obtained from the test samples. It has been shown that the energy absorbed by fluid motion of the liquid weld material due to the periodic behavior of the currents induced by the induction coil is an infinitesimal part of the energy released by the induction heater. This tends to indicate that the observed erosion is not due to the abrasive action of a swirling fluid motion. Since the weld material is primarily nickel, the erosion is believed to be due to a chemical action such that the molten weld material will break down stainless steel to absorb some of its iron and chromium components in order to form the eutectic composition of the three metals, nickel, chromium, and iron. This condition is aggravated by the high temperature present during the welding operation. The solution to the problem appears to be the use of this eutectic for weld material. The availability of this eutectic weld material may present a problem, however. It is recommended that the ramifications of these chemical phenomena be further investigated by a metallurgist. (auth)

37665 PRODUCTION OF ROUND PARTICLES OF CERAMIC MATERIAL. Casimer W. Krystyniak, Angelo T. Muccigrosso, and George L. Ploetz (to U. S. Atomic Energy Commission). U. S. Patent 3,146,281. Aug. 25, 1964.

A process is given for preparing spherical particles of boron-carbide poison for nuclear reactors. It comprises mixing boron carbide with a binder, compacting the mixture obtained, crushing the compacts formed into particles, abrading the particles to round their surfaces, mixing the rounded particles with graphite, heating the graphite–refractory mixture in an inert atmosphere to at least 2500°C, cooling to room temperature, abrading the mixture to smoothen the surfaces of the particles, and separating the nonspherical particles from the spherical ones by vibration on a glass table. (AEC)

Properties and Structure

Refer also to abstracts 37142, 37656, and 38247.

37666 (A/CONF.28/P/22) DEVELOPMENT OF ZIRCONIUM–NIOBIUM ALLOYS. C. E. Ells, S. B. Dalgaard, W. Evans, and W. R. Thomas (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.). May 1964. 15p.

Strength, ductility, and corrosion-resistance of Zr–2.5 wt% Nb and Zr–2.5 wt % Nb–0.5 wt % Cu were investigated for use in pressure tubes for Canadian power reactors. Heat treatments, irradiation, hydrogen effects, impact properties, creep properties, and corrosion in air and CO_2 were studied. (R.E.U.)

37667 (A/CONF.28/P/146) DEVELOPMENT OF MAGNESIUM ALLOYS FOR FUEL ELEMENTS IN THE UNITED KINGDOM. P. Greenfield (English Electric Co., Ltd., Whetstone, Leics, England). R. G. Coffin, G. C. E. Olds, B. Pickles, and T. C. Wells. May 1964. 15p.

For British civil reactors Magnox AL80 has been employed extensively for fuel element canning and structural components. To meet more stringent operating conditions and greater fuel element burn-up requirements, magnesium alloys have been developed with high creep strength and adequate ductility at reactor temperatures while having a neutron capture cross section of the same order as that of AL80. In addition, the properties of the magnesium-zirconium alloy ZA have been investigated in order to assess its suitability as a canning material. The work on ZA has shown that in most respects the properties of this alloy are superior to those of AL80 when considered for canning purposes. Diffusion of plutonium through ZA can walls during reactor service, however, would lead to early discharge of ZA canned elements. Interlayers between can and fuel are being examined in order to prevent such diffusion. Diffusion of plutonium does not occur in AL80 and burnups up to 5,470 Mwd/t maximum have been achieved using fine grained AL80 cans. Heat treatment of ZA for 96 hours at 600°C produces a marked increase in the creep strength of the material and renders it suitable for use as splitters and braces in which high creep strengths rather than high ductilities are required. Zirconium-containing magnesium alloys, however, are not metallurgically stable in moist carbon dioxide, zirconium hydride being precipitated by reaction with moisture. Such precipitation could lead to changes in properties during service and this has led to the examination of pre-hydrided ZA which is not susceptible to further modification in properties by hydriding during reactor operation. The properties of pre-hydrided ZA are markedly affected by the stage in manufacture at which the hydriding takes

place but it has been shown that WHP ZA (extruded, homogenized for 96 hours at 600°C, hydrided) has a much higher creep strength than ZA heat treated in any other way. Additions of manganese to ZA produce further improvements in creep strength, and both Magzan 2, containing 0.1 to 0.2% manganese and Magzan 4, containing about 0.4% manganese, have been investigated. Both of these alloys contain precipitated phases and Magzan 4 has not yet been produced with satisfactory homogeneity. Most attention has therefore been given in Magzan 2, which gives an excellent combination of high strength and ductility with a fine, stable grain size. For end caps, in which the volume of material is small and consequently the neutron capture cross section comparatively unimportant, Mg–Mn alloys containing 0.5 to 1.5% manganese have been investigated. In these alloys particularly, grain size plays a very large part in determining the creep properties, a grain coarsening treatment effecting improvements in creep strengths but lowering ductilities. With the higher manganese alloys, however, good combinations of high strength ductility, and moderate grain size can be achieved. Preliminary investigation on magnesium alloys manufactured from powder indicate that these can be produced with a very high level of creep strength and adequate ductility in short term tests but much remains to be done both in improvement ofproduction methods and determination of their properties. (auth)

37668 (A/CONF.28/P/158) THE PROPERTIES OF ZIRCONIUM ALLOYS FOR USE IN WATER-COOLED REACTORS. J. K. Dawson (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England), R. C. Asher, J. Boulton, B. Watkins, and J. N. Wanklyn. May 1964. 15p.

Recent work in the United Kingdom on the corrosion, hydriding, and mechanical properties of Zircaloy-2 and zirconium–2.5% niobium alloy is reviewed, with particular emphasis on the use of these materials in pressure-tube reactors. The resistance to oxidation of the Zr–2.5% Nb alloy by pressurized water or steam is slightly inferior to that of Zircaloy-2 and is more dependent on its metallurgical condition. Exposure to a high flux of fast neutrons increases the rate of oxidation of both alloys at 300 to 350°C. In the SGHWR at Winfrith Heath, the external walls of the pressure tubes may be exposed to moist carbon dioxide containing up to 10 per cent air. While Zircaloy-2 is adequately resistant to such exposure, Zr–2.5% Nb alloy has extremely high rates of oxidation in some heat treatment conditions. A particular advantage of the Zr–2.5% Nb alloy is that it absorbs less hydrogen than Zircaloy-2 during corrosion, whatever the prior heat treatment. Neither of these alloys would be suitable for use in superheated steam at about 500°C. An investigation aimed at understanding the behavior of zirconium alloys at this temperature is described. Experiments with small samples and experience in the manufacture of pressure tubes shows that annealed Zr–2.5% Nb alloy has strength comparable to that of cold-worked Zircaloy-2, and that higher strength may be achieved by cold-working or heat treatment without serious loss of ductility. Pressure tubes were manufactured from Zircaloy-2 with cold-work contents up to 30%, and no greater difficulty was encountered with 20% cold-worked Zr–2.5% Nb alloy despite its increased strength. The effect of hydrogen on mechanical properties was investigated. Hydrided material has a higher creep rate than the unhydrided alloys under thermal cycling conditions. The presence of hydrogen in excess of 10 ppm also lowers the energy to failure in impact tests. Preliminary results show that irradiation has the same general effect as hydrogen, lowering the impact energy at any given test temperature. The two effects may be additive for hydrogen contents above about 100 ppm. It is concluded that the use of either alloy as fuel cladding or pressure tubes operating at about 300°C would be technically feasible. The higher strength of the Zr–2.5% Nb alloy could be utilized by designing thinner pressure tubes, with a saving in neutron absorption. For a fixed temperature, there is then little difference between the predicted hydrogen contents after a service life of 20 to 30 years of pressure tubes made from the two alloys: the lower rate of hydrogen absorption of the Zr–2.5% Nb alloy would be counterbalanced by the thinner cross section. (auth)

37669 (A/CONF.28/P/333) SELF-DIFFUSION IN α- AND β-URANIUM. A. A. Bochvar, V. G. Kuznetsova, V. S. Sergeev, and F. P. Butra (U.S.S.R.). May 1964. 16p.

^{233}U tracer was used in experiments in which α-activity measurements and autoradiographs were made during diffusion annealing in high vacuum. The results indicate a definite anisotropy for both α- and β-uranium. For α-uranium, the self-diffusion in any crystallographic direction is a function of the angle of that direction with the [010] axis, being at a maximum (2×10^{-13} cm^2/sec) in the [100] and [001] directions and a minimum ($\leq 10^{-15}$ cm^2/sec at 640°C) in the [010] direction. The effects of the grain boundaries on the self-diffusion and the activation energy were also studied. The self-diffusion in the [100] and [001] directions was found to follow the equation $D = 9.1 \times 10^2 \exp[-67{,}000/RT]$ cm^2/sec. (D.L.C.)

37670 (A/CONF.28/P/337) STRUCTURE AND PROPERTIES OF TERNARY ALLOYS WITH THORIUM. T. A. Badajeva, G. K. Alekseenko, and R. I. Kuznetsova (U.S.S.R.). May 1964. 17p.

Experimental data are presented on the structure of the ternary alloys Th–Zr–Ti, Th–Zr–Ce, Th–Zr–Mo, and Th–Zr–Ni. Consideration is given to the study of metastable phases, the conditions of their formation, and their relation to the properties of alloys. Information is provided on the hardness of alloys hardened from the β-solid solution and tempered at 100 to 600°C. In the system Th–Zr–Ce, no wide region of hard ternary solutions based on the bcc lattice of β-zirconium was observed. The elements of the equilibrium diagram were plotted for the state of the Th–Zr–Ce system in the temperature range from 930°C to the room temperature. In the Th–Zr–Mo system, a region of ternary Th–Zr–Mo solid solution based on the bcc lattice was observed at 1000°C. A region of the alloys of this solution was established in which at high temperature hardening, together with the bcc lattice, a ω-phase resulting from a partial martensite transformation was observed. The systems Th–Zr–Mo and Th–Zr–Ni hardened from the region of a hard solution on the basis of a body-centered cubic lattice of β-zirconium were studied to show how the rate of cooling at hardening effects the formation of a ω-phase. A decay process of β-phase in these alloys tempered at 100 to 600°C was also studied. (auth)

37671 (A/CONF.28/P/421) SINTERED ALUMINUM PRODUCTS FOR ORGANIC-REACTOR APPLICATION. N. Hansen, P. Knudsen, A. C. Winther, and E. Adolph (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). May 1964. 16p.

Sintered aluminum products containing 7 to 11 wt % of

aluminum oxide have a satisfactory creep strength at the reactor temperature, but the elongation at creep rupture is very small. Tensile testing of specimens subjected to creep stresses for extended periods has, however, shown satisfactory elongation. Vacuum degassing of SAP stabilizes the material; thus fissure formation in the microstructure at elevated temperatures is avoided. Extended heat treatment of SAP at 500°C followed by microscopic examination has shown that vacuum-degassed material is completely stable. Neutron irradiation at 40 and 270°C has a slight effect on the mechanical properties of SAP as examined by tensile and impact testing. The compatibility between SAP and uranium dioxide is satisfactory. The compatibility between SAP and uranium monocarbide is unacceptable, unless a barrier layer is introduced. Flash welding of SAP canning tubes results in end closures of acceptable tightness and strength. A welding method utilizing a rotating arc is promising for the closing of SAP tubes with aluminum end caps. Finned tubes of SAP according to the fuel-element design were successfully extruded by a British manufacturer, and nondestructive methods for measuring the internal diameter and wall thickness of the tubes were developed. Alloy development work has resulted in a new type of aluminum/aluminum-oxide material manufactured by mechanical mixing of the constituents. The new alloys have properties comparable to those of SAP, although they are made by a completely different process. (auth)

37672 (A/CONF.28/P/431) ON THE THERMAL FATIGUE BEHAVIOR OF FUEL SHEATH MATERIAL SUBJECTED TO CONSTRAINED DEFORMATION CAUSED BY CORE MATERIAL. Masayuki Kawasaki and Masanobu Sasagawa (Japan Atomic Energy Research Inst., Tokyo). May 1964. 13p.

Sheath and core materials bonded together in a feul element into a single body are nevertheless subjected to different conditions of temperature and atmosphere. When the rigidity of the sheath material is lower than that of the core material, the sheath would yield to dimensional changes of the core during use in reactor and undergo constrained deformation. Hence, for fuel element design, safety analysis and use, it should be very important to study this constrained deformation from the standpoint of thermal fatigue behavior. For the study, a universal thermal fatigue testing machine of original design was used; this machine can be utilized not only for investigating such constrained deformation but also other thermal fatigue phenomena. The experimental method is to fix the core and sheath separately, and have the thermal strain induced by the difference in thermal cycling temperature range accurately transmitted to the sheath, thus permitting the induced stress behavior, microstructure and failure to be observed. Experiments were performed on 2S aluminum, Magnox A-12 alloy, and other reactor materials. (auth)

37673 (A/CONF.28/P/475) (UNCLASSIFIED) PHASE EQUILIBRIA BETWEEN INTERMETALLIC COMPOUNDS IN URANIUM ALLOYS. G. E. Petzow and S. Steeb (Max-Planck-Institut für Metallforschung, Stuttgart). May 1964. 15p.

Intermetallic uranium compounds are of great practical importance as constituents in most uranium alloys, as fissionable substances dispersed in metals of suitable nuclear properties, as reaction products between uranium-containing fuels and can materials, or as potential fuel materials. In all cases the intermetallic compounds influence the properties of uranium alloys, cans, and matrix materials of dispersion-type fuel elements. Therefore, the practical use of uranium-containing alloys required a good knowledge of constitution, properties, phase relations, and stabilities of intermetallic uranium compounds. Careful constitution investigations combined with corresponding measurements of the most interesting properties are normally the first step in establishing the desired knowledge. More than thirty phase diagrams of multicomponent uranium alloy systems were studied. Often quasibinary, quasiternary, etc., phase relations, and some ternary uranium compounds have been found. Under consideration of all known data in this field, the quasibinary systems can be divided into three types: systems between intermetallic uranium compounds, systems between one intermetallic uranium compound and one of the pure components, and systems between one intermetallic uranium compound and one intermetallic uranium-free compound. All these quasibinaries are simple eutectic systems if the boundary compounds exhibit different crystal structures. Generally, the two-phase regions in these eutectic systems extend over a wide range of concentration and temperature. In quasibinary systems having boundary compounds with the same crystal structure, complete solid solubility or ternary uranium compounds were observed. So far 12 new ternary compounds were found and determined. It is possible to give a systematic arrangement of the experimental results in terms of valence electron concentration, which in turn allows some predictions of the constitution of the quasibinaries and the nature of the ternary phases. Furthermore, on this basis the identification of unknown intermetallic uranium phases in technical alloys is possible. Preparation, workability, casting properties, melting points, thermal expansion, corrsoion and transformation behavior, and other properties of some quasibinary uranium alloys and ternary compounds were examined. It has been found that some of these alloys exhibit remarkable properties which make them attractive as potential fuel materials. (auth)

37674 (A/CONF.28/P/488) THE TIME-OF-FLIGHT METHOD FOR NEUTRON CRYSTAL STRUCTURE INVESTIGATIONS AND ITS POSSIBILITIES IN CONNECTION WITH VERY HIGH FLUX REACTORS. B. Buras (Polish Academy of Sciences. Inst. of Nuclear Research, Swierk), J. Leciejewicz, W. Nitc, I. Sosnowska, J. Sosnowski, and F. Shapiro. May 1964. 19p.

A new method for neutron structure investigations of powdered crystals using the time-of-flight technique is described. In this method a pulsed neutron beam is scattered on a powdered crystal, and the intensity of the scattered neutrons at a fixed angle is measured by means of neutron counters connected to a multichannel time analyzer. As a result an intensity vs wavelength curve is obtained. The peaks are indexed in the usual manner and the structure factors are obtained using a formula for the integrated intensity especially derived for this type of experiment. According to this formula the integrated intensity is proportional to the fourth power of the wavelength, which favors diffraction peaks for long wavelength so that peaks corresponding to 4 to 5 Å are also clearly visible. This is especially suitable for studies of crystals with large unit cells and when a very high resolution is needed. Additional advantages of this method are: no higher order contaminations and an appreciable/more than an order of magnitude/ shortening of the exposure time as compared with the

conventional method. The feasibility of the method was proved experimentally using powdered samples of Pb, Al, Si, Zn, and ZnO. In this method one can also apply to the crystalline sample an external field (e.g., an electric field) pulsed with the same frequency as the neutrons but shifted in time. In this way the study of transient effects (relaxation phenomena) with relaxation times from 0.1 msec to 200 msec and more should be possible. (auth)

37675 (A/CONF.28/P/506) URANIUM ALLOYS. A. Bar-Or, G. Hirsch, I. Goldstein, and P. Wynblatt (Israel. Atomic Energy Commission, Tel-Aviv). May 1964. 16p.

In connection with a study of uranium alloys, two mechanisms for improving the behaviour of metallic uranium under irradiation were examined. The mechanism of grain refinement was investigated by studying the β/α transformation in dilute uranium alloys, and the γ phase stabilization in high-concentration alloys was studied by following the mechanism of $\gamma \rightarrow \alpha + \gamma'$ decomposition. As regards the β/α transformation, both the rate of growth, G, and the rate of nucleation, N, were measured in several alloys, the former from the change in length of isothermally formed columnar grains. It was found that the results could be expressed in terms of the Volmer-Turnbull theories of nucleation and growth. The interface energies $\sigma_{\alpha\beta}$ of the various alloys were calculated on this basis, both from nucleation and from growth, and were found to be of the same order of magnitude. Assuming that linear extrapolation of the $\sigma_{\alpha\beta}$ values found for the various alloys to zero chromium is permissible, the value of the interface energy for pure uranium from both nucleation and growth measurements is 6 ergs/cm^2. The appearance of columnar grains permitted the measurement of dihedral angles, which permitted calculation of the ratio $\sigma_{\alpha\beta}/\sigma_{\alpha\alpha}$, where $\sigma_{\alpha\alpha}$ is the interface α,α grain boundary energy. The internal structure of these alloys was also examined, using super-pure uranium for alloying. Clear pearlite structure was revealed, with characteristic "Hebrew Script" sub-lamellas. An attempt was also made, taking the values of G and N, to calculate the overall transformation on the basis of the Johnson and Mehl theory. The study of the $\gamma \rightarrow \alpha + \gamma'$ transformation was carried out on uranium high-molybdenum alloys using crystallographic techniques for determining the two TTT curves for the $\gamma \rightarrow \alpha$; $\gamma \rightarrow \gamma'$ transformation. It was found that both curves are strongly affected by small impurities, which may explain discrepancies in previous work. (auth)

37676 (A/CONF.28/P/573) SOME STUDIES CONCERNING STRUCTURE, RADIATION DAMAGE ANNEALING AND FISSION PRODUCT DIFFUSION IN PYROLYTIC CARBON. B. Chinaglia, M. Domenici, F. Pieragostini, and H. Walther (Societa Ricerche Impianti Nucleari. Centro Ricerche Nucleari, Saluggia, Italy). May 1964.

A number of studies on pyrolytic carbon was performed in order to contribute to the general understanding of this material. Its structure was characterized mainly by neutron diffraction; data on preferred orientation, porosity, layer order, and crystallite dimensions, perpendicular and parallel to deposition planes were obtained. The specific advantages of neutron diffraction methods against the corresponding x-ray techniques are discussed. The investigated materials include various pyrolytic carbon samples which were treated at different temperatures (2000 to 3000°C) after deposition and also a sample of amorphous cellulose carbon. The samples, previously characterized by diffraction methods, were irradiated at 78°K up to fast neutron doses (E > 1 Mev) of 10^{18} cm^{-2}. Subsequent recovery of electric resistivity and structural parameters was carried out in order to identify annealing stages and to interpret the recovery process. In other samples, having the same characteristics, the diffusion of some fission products (Zr, Nb, Xe, Cs, and Ba) was studied, by measuring both the diffusion coefficients and the probabilities of evaporation from the surface. In the experimental procedure fission fragments are injected into the sample by fission recoil from a thin uranium foil, and their distribution and the escaped fraction after heating at high temperature are measured. The influence of the diffusion and evaporation processes on the loss of the above elements is discussed. (auth)

37677 (A/CONF.28/P/701) METALLURGICAL PROPERTIES OF SOME URANIUM ALLOYS. B. Djuric, Dj. Drobnjak, Dj. Lazarevic, S. Malcic, A. Mihailovic, Dj. Milosavljevic, and S. Milosevic (Institut za Nuklearne Nauke "Boris Kidric," Belgrade). May 1964. 16p.

Experimental work on some dilute uranium alloys, especially on the uranium-molybdenum system, is reported. An alloy with 0.5 wt.% Mo (total impurities in uranium about 1000 ppm) in as-cast condition has fine fairly equiaxed grains ranging from 150 to 250 microns. The grains are completely occupied by a lamellar perlite. This alloy was subjected to long term annealing in a high alpha-phase temperature range. It was fairly convincingly shown that the grains did not undergo any pronounced enlargement by annealing at 450 to 550°C for 2500 hours. In the alloy subjected to annealing at 550°C for more than 2500 hr, an observable grain growth took place. Isothermal treatment of the alloy in the range of the upper "C" curve yields, after the transformation is complete, relatively fine alpha grains whose size decreases with decreasing temperature of the treatment. The average grain size obtained by isothermal treatment at 550°C was 35 microns and did not significantly change after heating for 2000 hr at 550°C. Quenching from the gamma range in water and salted water gives, besides the beta phase, a fine needlelike α'_a phase. The martensitic phase is athermal and probably results from the direct decomposition $\gamma \rightarrow \alpha'_a$. Quenching from the $\beta + \gamma$ and β range gives no athermal martensitic phase. The ternary system with aluminum shows a pronounced cooperative effect of molybdenum and aluminum upon the grain size in the as-cast alloy. The finest and most regular grains (50 microns in average) are obtained with the 0.6 wt.% Mo and 500 ppm Al alloy. The modified Jominy-test shows that the cooling rate has a less effect upon the alpha grain size in this alloy than in the U–0.5 wt.% Mo alloy. The present investigation of the kinetics of phase transformations in the U–Nb system (up to 5 wt.% Nb) indicates a slight beta phase stabilization. In the range of 2–3 wt.% Nb a significant change in microstructure and lattice parameters of alpha uranium were observed. (auth)

37678 (A/CONF.28/P/727) A NEW METHOD FOR MEASURING THE TENDENCY TO BRITTLE FRACTURE IN REACTOR VESSEL STEELS. H. C. van Elst, W. L. Korbee, E. C. J. Buys, and C. A. Verbraak (Netherlands. Nijverheidsorganisatie, TNO, The Hague). May 1964. 15p.

From a statistical evaluation of twinning resulting from brittle fracture in steel it could be concluded that the preferred directions of twinning in this case were similar to the preferred twinning directions in shockloaded specimens. From this similarity of twin-directions it was concluded that a running brittle fracture in steel creates stress

waves. Such an emission of stress waves by a brittle fracture, however, seems only conceivable if the fracture propagates by discrete steps. It was possible to verify this point of view by applying ultra-high-speed photographic methods for the recording of brittle fracture phenomena in steel plates. The results of these experiments confirmed the hypothesis of intermittent brittle fracture propagation in steel. The propagation of a brittle fracture in steel proceeds as a sequence of alternatively sudden fracture steps and halting times. Also the dynamic stress pattern at the tip of the moving brittle fracture and the emitted stress waves could be recorded, when a sheet of photostress material was glued to the steel plate. (auth)

37679 (A/CONF.28/P/750) RELATION BETWEEN THE ORIGIN, POWDER CHARACTERISTICS AND SINTERING TREATMENTS ON THE DENSIFICATION AND MICROSTRUCTURES OF COMPACTS OF URANIA AND THORIA. V. K. Moorthy, A. K. Kulkarni, and S. V. K. Rao (India. Atomic Energy Establishment, Trombay). May 1964. 15p.

The relations between the origin, powder characteristics and sintering treatments on the densification and microstructure of compacts of urania and thoria were studied. The oxide powders were prepared by thermal decomposition of uranyl and thorium compounds viz. tennate, benzoate, oxalate etc. The microstructure of a sintered compact influences some of its physical properties such as thermal conductivity and fission gas retention and as such is an important factor responsible for the difference in performance of pellets of the same density during service in a reactor. (auth)

37680 (A/CONF.28/P/757) THE STRUCTURE AND THE MECHANICAL PROPERTIES OF WELDED ZIRCALOY-2. E. Bodmer, J. J. Chene, R. O. Eriksson, and R. Ferrarini (Sulzer Bros., Ltd., Winterthur, Switzerland). May 1964. 19p.

Studies were made for the design of mechanically stressed weldments in Zircaloy-2. Static tensile, bend, fatigue, and creep rupture tests were made on Zircaloy-2 and Zr–2.5% Nb after electron beam, flash, and argon-arc welding. The results show that a Martensite to fine Widmanstatten structure gives better strength than the coarse transformation structure produced by slow cooling, that thermally affected zones are likely to be the weakest part in the weld seam, and that electron-beam welding is best for producing mechanically stressed welds in cold-worked Zircaloy-2. (D.L.C.)

37681 (EURAEC-1082) THE MECHANISM OF DIFFUSION AND PRECIPITATION OF HYDROGEN IN ZIRCONIUM AND ITS ALLOYS. Quarterly Report No. 5, February 1–April 30, 1964. (Bologna. Universita. Istituto di Fisica "A. Righi"). Work Performed under United States–Euratom Joint Research and Development Program. Contract 026-64-3-TEEI(RD). 58p.

The hydrogenation of zirconium is studied by electron microscopy, x-ray diffraction analysis, electric conductivity measurements, optical microscopy, hydrogen absorption through oxide films, quenching-deformation techniques, and diffusion and precipitation mechanisms. The results of these studies are discussed along with testing equipment developed for testing purposes. (N.W.R.)

37682 (MIT-1310-1) MECHANICAL PROPERTIES OF METALS AT LOW TEMPERATURE. Annual Progress Report, October 1963 to Present. (Massachusetts Inst. of Tech., Cambridge. Div. of Sponsored Research). [1964]. Contract AT(30-1)-1310. 8p.

A summary is presented of progress made in the study of deformation and fracture of copper crystals, deformation of magnesium crystals, and effect of neutron irradiation on the mechanical properties of iron crystals. (N.W.R.)

37683 (NP-14215) THE FRICTION AND STRENGTH OF GRAPHITE AT HIGH TEMPERATURES. Report No. 62. G. W. Rowe and D. J. Baldwin (Tube Investments Research Labs., Hinxton Hall, Cambridge, England). Aug. 29, 1958. 37p.

An experimental study was conducted of the friction and strength of graphite at temperatures up to 2000°C in a high vacuum furnace. The results show that under heavy loads the friction of outgassed graphite falls as the specimen temperature is raised. This agrees with published results obtained by other workers at light loads. Published data showing that tensile strength of graphite increases as the temperature is raised are also confirmed, but are found to be misleading. The results show that the shear strength under compression behaves in the same way as the tensile strength, both being greatly influenced by atmospheric contamination. The apparently contradictory findings that the friction decreases while the strength increases with increasing temperature are shown to depend upon the graphite not being outgassed before the strength measurements. If the shear specimens are outgassed at 1600°C before test, the room-temperature strength is the same as the strength at 1600°C, both being measured in vacuo. Temperature alone has little influence on the strength of graphite. The observed fall in friction with increasing temperature is probably due to increased ease of surface orientation. The equipment developed for measurement of strength at high temperatures (2000°C) in high vacuum (0.1 microns) is described. (auth)

37684 (TID-20984) ENGINEERING AND CONTINUUM ASPECTS OF HIGH-STRENGTH MATERIALS. Technical Report No. 7. D. C. Drucker (Brown Univ., Providence). June 1964. Contract AT(30-1)-2394. 59p.

The distribution is drawn between special devices, for which extremely strong but fully brittle materials are permissible, and large engineering structures and machines for which some ductility is essential. Single perfect crystals are intriguing possibilities for devices, but much weaker composites (in some sense) are required when dimensions are large. The basic similarity is traced between an engineering structure formed by joining structural elements together, and a metallurgical structure formed by sintering particles together, or a fiber or whisker and matrix composite, or a polycrystal or two phase alloy with grain boundaries. Continuum mechanics in a very elementary form is applied on the macroscale and on the microscale to explore the effect of residual stress and thermal stress, to study size effects in sintered WC–Co and the problem of optimum volumetric ratio of the components, to examine the influence of grain size and grain boundaries on yield strength and on creep strength of polycrystals. A simple two-dimensional model of regular hexagons embedded in an elastic or in a viscous or in a perfectly plastic matrix illustrates several aspects of the behavior of polycrystals as well as of sintered carbides. Some of the features of material behavior which occur on the microscale, when significant dimensions are small fractions of a micron, are taken into account by an appropriate modification of the properties of the continuum representing each constituent. (auth)

37685 (TID-20999) AN EVALUATION OF THE ROLE OF DEFORMATION TWINNING IN THE PLASTIC DEFOR-

MATION OF ZIRCONIUM. Eleventh Quarterly Progress Report. (Florida. Univ., Gainesville. Engineering and Industrial Experiment Station). June 1964. Contract AT (38-1)-252. 33p.

The effect of deformation by rolling and tension on the incidence of twinning in zirconium was studied using quantitative metallographic procedures. The deformation was conducted at 77°K on transverse specimens, which twin extensively at low temperatures. The distribution of the angles between the twin traces and the longitudinal axis, the twin boundary surface area per unit volume (S_V), and the volume fraction of twins (V_V) were determined for specimens deformed to strains varying from 0.2 to 6.0%. The distribution of the angles between the twin traces and the longitudinal axis was different for the two types of deformation. The twin boundary surface area per unit volume and volume fraction of twins increased with increasing strain and were apparently not affected by the mode of deformation. Comparison with data obtained at room temperature shows that twinning becomes increasingly more important as the temperature at which the deformation is carried out is decreased. (auth)

37686 (AEC-tr-6398(p.322-7)) STUDY OF THE DIFFUSION OF SULFUR IN COPPER AND ITS ALLOYS USING RADIOACTIVE ISOTOPES. M. M. Pavlyuchenko, I. F. Kanonyuk, and A. D. Markin. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 248-?(1961).

The diffusion of sulfur into electrolytic copper during annealing at 800 to 1000°K was studied using ^{35}S of high specific activity in benzene. The distribution of sulfur was similarily studied for diffusion layers of alloys of copper with tin, lead, aluminum, and silver. (R.E.U.)

37687 (AEC-tr-6398(p.328-33)) INVESTIGATION OF DIFFUSION PROCESSES IN SELENIUM RECTIFIERS USING RADIOACTIVE ISOTOPES. G. B. Abdullaev and G. A. Akhundov. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 252-?(1961).

Impurity diffusion in semiconductors and in contacts was studied using radioactive tracers. Results are given for diffusion of thallium, tin, and indium in polycrystalline selenium; of cadmium, tin, and thallium in cadmium–tin alloy; and of thallium and selenium in Tl_2Se. The production of selenium rectifying systems with layers of Tl_2Se was also studied. (R.E.U.)

37688 (AEC-tr-6398(p.334-7)) INVESTIGATION OF THE DIFFUSION OF CERTAIN ELEMENTS IN SELENIUM. Z. A. Aliyarova and G. B. Abdullaev. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 256-?(1961).

Diffusion coefficients for sulfur, iron, and selenium in selenium were determined using radioactive tracers and the method of removing layers. (R.E.U.)

37689 THE CRYSTAL STRUCTURE OF Pu_5Si_3. Don T. Cromer, Allen C. Larson, and R. B. Roof, Jr. (Los Alamos Scientific Lab., N. Mex.). Acta Cryst., 17: 947-50 (Aug. 20, 1964). (LADC-5959)

The intermetallic compound Pu_5Si_3 is isostructural with W_5Si_3. The unit cell is tetragonal, space group No. 140, I4/mcm, a = 11.409, c = 5.448 Å, and there are four formula units per unit cell. Least-squares refinement of counter data was carried out. (auth)

37690 THE CRYSTAL STRUCTURE OF $EuSO_4$ AND $EuCO_3$. I. Mayer, E. Levy, and A. Glasner (Hebrew Univ., Jerusalem). Acta Cryst., 17: 1071-2(Aug. 20, 1964).

The crystal structures of $EuSO_4$ and $EuCO_3$ were studied by the powder diffraction method. The space group found for $EuSO_4$ is Pnma (D_{2h}^{16}) while for $EuCO_3$ it is Pmcn (Pnma) (D_{2h}^{16}). The orthorhombic lattice constants of $EuSO_4$ are a = 8.333, b = 5.326, c = 6.861 Å, while those of $EuCO_3$ are a = 5.102, b = 8.422, c = 6.030 Å. The radius of divalent europium is discussed. (auth)

37691 THE CRYSTAL STRUCTURE OF NbAs (COMMENTS). Sigrid Furuseth and Arne Kjekshus (Universitetet, Oslo). Acta Cryst., 17: 1077-8(Aug. 20, 1964).

A crystal structure investigation of NbAs showed that a = 3.4517, c = 11.680 Å, c/a = 3.3838 in agreement with previously reported values. The composition NbAs was ascertained by density measurements. On the basis of the pycnometric density 7.93 g cm^{-3} (at 25°C), the unit cell contains 4 NbAs groups (Z_c = 3.96). Observed and calculated structure factors for NbAs are tabulated. Values reported by others are also discussed. (P.C.H.)

37692 ZIRCONIUM ALLOYS AS FUEL-CLADDING MATERIALS FOR WATER-COOLED POWER REACTORS. A. van der Linde. Atoomenergie Haar Toepassingen, 6: 111-18(June 1964). (In Dutch)

The use of Zr alloys as cladding material for fuels in water-cooled reactors is discussed. After a consideration of the use of Zircaloy-2, especially in the West, for fuel cladding, the research done in the Soviet Union on Zr–Nb alloys is reviewed. (tr-auth)

37693 MATERIALS AT HIGH TEMPERATURES. L. G. Carpenter (Royal Aircraft Establishment, Farnborough, Hants, Eng.). Brit. J. Appl. Phys., 15: 871-82 (Aug. 1964).

Some general trends of the physical properties of solids with temperature are indicated. Attention is directed to the properties and applications of some refractory metals and alloys, commonly used ceramics, and carbon and graphite, at temperatures of 1500°C upwards. 75 references. (auth)

37694 POSITRON-ELECTRON ANNIHILATION IN PLASTICALLY DEFORMED METALS. I. Ya. Dekhtyar, D. A. Levina, and V. S. Mikhalenkov (Inst. of Metal Physics, Academy of Sciences, Ukrainian SSR). Dokl. Akad. Nauk SSSR, 156: 795-8(June 1, 1964). (In Russian)

Changes in atomic structure taking place during plastic deformation of a metal can be inferred from changes in the angular distribution of annihilation photons. Nickel and a nickel alloy containing 62% iron were used because the contributions of d-electrons to the form of the annihilation spectrum is significant in these metals. The samples were deformed by rolling disks 15 mm in diameter and 2 mm thick down to 70–76%. The initial state was obtained by annealing the sample in pure argon at 950°C for a period of 3 hours. Tracer ^{22}Na was used as a source of positrons. The angular distribution of annihilation photons was determined for samples in the deformed and annealed states, and it was found that in all cases, the maximum annihilation count rate for the annealed samples is lower than it is for the deformed samples. This effect cannot be ascribed to the effect of texture, since face-centered cubic metals do not show any anisotrophy in the angular distribution of γ quanta occurring as a result of positron-electron annihilation. The increase in the annihilation count rate at low scattering angles for deformed samples is associated with an increase in the density of occupied states in the d-band. Thus, deformation causes a change in the structure of the electron energy spectrum in a metal. (TTT)

37695 ELASTIC CONSTANTS OF TITANIUM–NIOBIUM ALLOYS. S. G. Fedotov and O. K. Belousov (Baikov Inst. of Metallurgy, Academy of Sciences, USSR). Fiz. Metal. i Metalloved., 17: 732-6(May 1964). (In Russian)

The elastic constants of Ti–Nb alloys were measured for a wide range of concentrations (to 60 at.% Nb) and for prolonged annealing and tempering in the β phase. It is shown that metastable phases produced by annealing strongly influence the tensile constants. The decay mode of unstable β-solid solutions was developed using the elasticity modulus as a function of temperature. (tr-auth)

37696 FRACTURING OF THORIUM OXIDE CRYSTALS IN AN ELECTRON MICROSCOPE. V. K. Pirogov (Inst. of Radiophysics and Electronics, Novosibirsk, USSR). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 2, Ser. Tekhn. Nauk, No. 1, 130-1(1964). (In Russian)

In the decomposition of ThO_2 crystals in an electron microscope a single vacancy was first observed in the center of the crystal. Decomposition spread to the periphery. There was no correlation with crystal size. Structural imperfections seemed to play a basic role in the process. (IIC-MG)

37697 MAGNETIC AND STRUCTURAL CHARACTERISTICS OF LANTHANIDE–NICKEL COMPOUNDS. R. E. Walline and W. E. Wallace (Univ. of Pittsburgh). J. Chem. Phys., 41: 1587-91(Sept. 15, 1964).

The magnetic and structural characteristics of 11 intermetallic compounds represented by the formula LnNi are reported. The five compounds with Ln = Dy, Ho, Er, Tm, and Y are isomorphous and occur in the FeB structure. The others, with Ln = Ce, Pr, Nd, Sm, Gd, and Tb, form in the CrB structure, YNi and CeNi exhibit only Pauli paramagnetism down to 4.2°K. The others order magnetically with Curie temperatures ranging from 8°K for TmNi to 71°K for GdNi. Nickel appears to be nonmagnetic in the series and CeNi is nonmagnetic and hence Ce is quadripositive in CeNi. Curie–Weiss behavior is obeyed in the paramagnetic region for the compounds containing a magnetic Ln atom, except for TmNi, which exhibits a tendency toward Van Vleck-type temperature-independent paramagnetism at low temperatures. This and the fact that the observed saturation moments are well below the free tripositive lanthanide ion moments suggests that appreciable crystal field quenching of the orbital contribution occurs in these compounds. Except for TmNi, effective moments in the paramagnetic region are as expected for the free tripositive ions. (auth)

37698 ZIRCONIUM DIOXIDE–OXYGEN REACTIONS. I. MOLECULAR OXYGEN ADSORPTION WITH ELECTRON TRANSFER. Tennyson Smith (North American Aviation Science Center, Canoga Park, Calif.). J. Electrochem. Soc., 111: 1020-7(Sept. 1964).

The rates and amounts of oxygen pickup by samples of powdered ZrO_2 were measured as a function of temperature (400–900°C), oxygen pressure (10^{-5} to 760 mm Hg), and particle size. Many experiments, performed to correlate oxygen pickup with the mass of oxide and with the oxide surface, indicate that oxygen pickup is primarily a surface phenomenon. After complete reduction of the ZrO_2 adsorbed surface oxygen, approximately one atomic monolayer of oxygen will adsorb irreversibly, and about 5% of the total adsorbed oxygen can be reversibly adsorbed and desorbed as molecules. The apparent activation energy for the adsorption of molecular oxygen is about 35 kcal/mole and for desorption about 53 kcal/mole, as compared to about 58 kcal/mole for adsorption of atomic oxygen. From theoretical calculations it was concluded that electron transfer must occur (oxygen adsorbs as O_2^-), and this molecular oxygen anion adsorbs as a mobile layer. (P.C.H.)

37699 ZIRCONIUM DIOXIDE–OXYGEN REACTIONS. II. CHEMISORPTION OF ATOMIC OXYGEN. Tennyson Smith (North American Aviation Science Center, Canoga Park, Calif.). J. Electrochem. Soc., 111: 1027-31(Sept. 1964).

The chemisorption of oxygen on zirconium dioxide was studied in the temperature range 400–900°C and oxygen pressure range 10^{-5} to 760 mm Hg. Analysis of the kinetic data indicates that except for about 5–10% the oxygen adsorbs as an atomic monolayer. The proposed mechanism involves primary adsorption of molecular oxygen which then dissociates and beomes adsorbed as atoms. The temperature coefficient for the primary molecular adsorption and secondary atomic adsorption is 35 and 58 kcal/mole, respectively. The primary adsorption is oxygen-pressure-dependent; whereas, the secondary adsorption is not. (auth)

37700 THE BEHAVIOUR OF GLASSES AND CERAMICS AT HIGH RATES OF HEAT TRANSFER. R. A. Dugdale, R. C. McVickers, and S. D. Ford (Atomic Energy Research Establishment, Harwell, Berks. Eng.). J. Nucl. Mater., 12: 1-15(May-June 1964).

An experimental investigation on the behavior of glasses and ceramics at high rates of heat transfer was made with a pulsed arc discharge of duration ~20 μsec that could deliver up to 17 joule/cm^2 to specimens of various glasses and ceramics; craze cracking, flaking, weakening, and erosion occurred to various degrees depending on the particular material and energy delivered. With a ballistic impulse device, evaporation was assessed and shown to be responsible for bursting of discharge tubes under certain conditions. In multiple cycles specimens developed surface modifications of which the appearance of nodules on alumina was a notable feature. The effects were then investigated in more detail using a pulsed arc discharge in which the power decayed exponentially with a time constant of 400 μsec. This discharge, capable of delivering up to 30 joule/cm^2, produced similar effects but in a thicker surface layer more suitable for subsequent examination by sectioning and metallographic examination. The maximum surface temperatures were assessed mainly through a set of observations on the melting of metal surfaces exposed to the discharge and also by calorimetry in conjunction with the known exponential waveform of the heat pulse; thresholds for damage were determined. The dimensions of flakes produced on glasses were found to depend on the energy delivered, the duration of the heat pulse, and the coefficient of expansion; these flakes are caused by tensile cracking on cooling after viscous flow during heating and not by cracking in compression. The behavior of electrical porcelain and alumina ceramics was more complex owing to cracking in compression and spalling during heating, but the presence of a glassy phase tended to inhibit these effects. Deformation of alumina while hot involved twinning. (P.C.H.)

37701 THE BODY-CENTRED-CUBIC TO FACE-CENTRED-CUBIC PHASE TRANSFORMATION IN THORIUM AND SOME THORIUM-RICH ALLOYS. G. H. Bannister (Atomic Energy Research Establishment, Harwell, Berks, Eng.) and J. R. Thomson. J. Nucl. Mater., 12: 16-23(May-June 1964). (AERE-R-4428)

The fcc (α) → bcc (β) phase transformation of thorium and several thorium-rich alloys was studied by differen-

tial thermal analysis. Indium and silicon had no significant effect on the transformation temperature while aluminum, cerium, hafnium, uranium, and zirconium lowered it. The results on thorium–cerium alloys are consistent with an inverse peritectic reaction at about 30 at. % cerium and 1300°C and a revised form of the thorium-rich part of the thorium–cerium phase diagram is proposed. Thermal analysis and annealing and quenching results place the thorium/Th_3Si_2 eutectic temperature at 1439 ± 8°C. The results on Th–U alloys indicate that uranium lowers the transformation temperature to a eutectoid at 1343 ± 17°C and that the solubility of uranium in α–thorium is approximately 2.7 at. % at this temperature. (auth)

37702 HYDROGEN EMBRITTLEMENT OF A 1 WT % Cr 0.5 WT % Mo PRESSURE VESSEL STEEL IN HIGH-PRESSURE WATER. D. R. Harries (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 12: 24-9(May-June 1964).

Tensile specimens of a 1 wt % Cr/0.5 wt % Mo pressure vessel steel were exposed for 107 days both in contact and isolated from the water at 250°C in the out-of-pile and in-pile sections respectively of a high pressure water loop. The results of room temperature tests showed no evidence of permanent chemical embrittlement or structural defects such as blisters and cracks due to hydrogen up-take in the steel. The only changes in properties obtained were produced by fast neutron-atom displacements in the steel specimens irradiated in the in-pile section of the loop. (auth)

37703 CHARACTERISTICS OF VACUUM-DISTILLED BERYLLIUM. E. D. Levine, J. P. Pemsler, and S. H. Gelles (Kennecott Copper Corp., Lexington, Mass.). J. Nucl. Mater., 12: 40-9(May-June 1964).

The distribution of residual impurities in distilled beryllium was studied in detail, and fabrication procedures were developed that resulted in the preparation of samples having a fine, uniform, recrystallized grain structure. These procedures involved attritioning to powder and extruding into flats. Impurity studies revealed that in addition to trace amounts of soluble impurities, insoluble particles containing iron and silicon exist; and that these particles probably limit ductility severely. A reduction in both soluble and insoluble impurities was obtained by performing a second distillation. Mechanical property studies revealed that double-distilled beryllium exhibits considerably greater three-dimensional ductility than material of lower purity. In wide-sheet bend tests, bend angles at fracture of 50 to 70° were observed. (P.C.H.)

37704 THE EFFECT OF SMALL ADDITIONS OF IRON AND ALUMINUM ON THE TENSILE PROPERTIES OF ALPHA URANIUM. D. M. R. Taplin and J. W. Martin (Oxford Univ.). J. Nucl. Mater., 12: 50-5(May-June 1964).

A study was made of the tensile properties of three grades of commercial purity uranium between –183 and 350°C. The effect of additions of iron and aluminum, heat treatment, and grain shape on the ductile/brittle transition was investigated and the results are interpreted in terms of the existing theories of fracture. (auth)

37705 A STUDY OF THE INTERDIFFUSION OF ALUMINUM AND ZIRCONIUM. G. V. Kidson and G. D. Miller (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater., 12: 61-9(May-June 1964).

A study of the interdiffusion of aluminum and zirconium was made as a function of time and temperature. Only one intermediate alloy phase, $ZrAl_3$, was detected in the diffusion zone, and grew according to the empirical relation $W(T,t) \leq [2.22 \times 10^9 \exp - (46{,}000/RT)]t^{1/2}$ cm/$h^{1/2}$. The diffusion mechanism in $ZrAl_3$ is discussed in terms of its structure. (auth)

37706 MORPHOLOGY OF α PSEUDO-GRAINS OF URANIUM–MOLYBDENUM ALLOYS IN THE NEAR EQUILIBRIUM STATE. J. Lehmann and J. Decours (CEN, Saclay, France). J. Nucl. Mater., 12: 70-82(May-June 1964). (In French)

The influence of γ-transformation temperature, γ grain size, molybdenum content, and nucleation mode of the α phase on the morphology of dilute uranium–molybdenum alloys was demonstrated. The size of the α pseudo-grains is a function of the temperature at which transformation begins, irrespective of whether this takes place in the (β + γ) phase field or the (α + γ) phase field. The initial γ grain size has an influence both on the form and on the size of the α pseudo-grains. A structure of coarse γ grains results in faster growth of the β phase and by a displacement of the TTT curves for the γ → β transformation toward longer times. A reduction in molybdenum content makes for larger α pseudo-grains; this is connected with the volume ratio between the β and γ phases at the start of the transformation. The presence of large α pseudo-grains (300–500 μm) in a matrix of fine grains (80 μm) is due to sympathetic nucleation of the α phase when the cooling rate is too high. The larger the γ grain size, the lower is the range of cooling rates that produce a homogeneous microstructure. (auth)

37707 THE β-PHASE TRANSFORMATION OF SOME ZIRCONIUM–THORIUM ALLOYS. C. G. Hanson, V. G. Rivlin, and B. A. Hatt (Fulmer Research Inst. Ltd., Stoke Poges, Bucks, Eng.). J. Nucl. Mater., 12: 83-93(May-June 1964).

An investigation of the quenching and aging behavior of the bcc β-phase in the zirconium–thorium system was carried out with the aim of studying the metastable ω-phase known to occur in other zirconium systems. The β-phase can be retained on quenching in the composition range 22–30 at. % thorium, but there is no evidence for the occurrence of the ω-phase. However, a new metastable phase, denotated α″, with an orthorhombic structure was observed in the same composition range. The α″-phase has the orientation $[100]_{\alpha''}$ at 5°16′ from $[00\bar{1}]_{\beta}$, $[010]_{\alpha''}$ 5°16′ from $[\bar{1}\bar{1}0]_{\beta}$ and $[001]_{\alpha''}$ parallel to $[\bar{1}10]_{\beta}$ and is believed to be a product of deformation strains on the β-phase with atom positions intermediate between those of the β and the close-packed hexagonal α′ phases. (auth)

37708 METALLOGRAPHY OF PLUTONIUM. B. Sprid (CEN, Fontenay aux Roses, France). J. Nucl. Mater., 12: 94-112(May-June 1964). (In French)

Various methods of micrographic examination of both pure and stabilized plutonium were tried out. The polishing and electrolytic etching characteristics of several baths were studied, as were the conditions of examination by polarized light. Epitaxial oxide deposits, which reveal the structure in natural light, were formed by atmospheric, chemical, and anodic oxidation. By the use of these methods, it was possible to reveal a polygonized sub-structure formed at high temperature; the conditions necessary for its formation were determined. A method for identifying plutonium hydride, PuH_2, by oxide deposition permitted the role of hydrogen in the substructure formation mechanism to be examined in detail. (auth)

37709 TRANSMISSION ELECTRON MICROSCOPY OF URANIUM MONOCARBIDE. J. L. Whitton (Dounreay Experimental Reactor Establishment, Thurso, Caithness, Scotland). J. Nucl. Mater., 12: 115-19(May-June 1964). (TRG-Report-612)

A technique is described for obtaining thin samples of UC for transmission electron microscopy. Dislocation arrays were not observed in stoichiometric or slightly uranium-rich specimens. The dislocation arrays always appeared on parallel planes, each plane containing dislocations of one sign only, opposite to that for the other plane. The dislocations were evenly spaced. Dislocation arrays were observed in some regions of platelets projecting from the foil. These projections were mostly UC_2 with a thin film of UC. Platelet tips that protruded from the edge of the foil gave a dicarbide diffraction pattern. Selected area diffraction patterns from the center of the bands of dislocations gave mainly a monocarbide pattern with some weaker unidentified spots. (P.C.H.)

37710 MAGNETISM RESEARCH WITH POLARIZED NEUTRONS AT THE CENTRO DI STUDI NUCLEARI DELLA CASACCIA DEL C. N. E. N., ROMA, ITALY. B. Antonini (CNEN, Rome), G. P. Felcher, F. Menzinger, A. Paoletti, F. P. Ricci, and L. Passari. J. Phys., 25: 604-9(May 1964).

Polarized neutrons techniques were used for investigating ferromagnetic materials. Work carried out in the field of magnetism is reviewed. (auth)

37711 SCATTERING OF COLD NEUTRONS BY THE PHONONS IN NICKEL. S. Hautecler and W. Van Dingenen (CEN, Mol, Belg.). J. Phys., 25: 653-6(May 1964). (In French)

The neutron spectrometer of BR1 was used to study the crystal dynamics of Ni by a time of flight method. Energy measurements of about 50 phonons allow approximate plots of scattering curves in the (0 1 $\bar{1}$) plane to be made. A small number of points of dispersion curves $\nu(q)$ is determined for the wave vector q directed along symmetry directions [100], [110], and [111]. (auth)

37712 PYROLYTIC TUNGSTEN PARTS AND COATINGS RESIST HEAT. M. Basche (High Temperature Materials, Inc., Brighton, Mass.). Mater. Design Eng., 60: No. 2, 82-5(Aug. 1964).

The fabrication of pyrolytic tungsten products in a wide variety of shapes by vapor deposition is discussed. The mechanical and thermal properties of pyrolytic tungsten and its uses are reported. (P.C.H.)

37713 CRYSTALLIZATION OF Be–Nb ALLOYS. N. D. Nagorskaya, L. V. Molchanova, M. V. Raevskaya, A. V. Novoselova, I. N. Fridlyander, K. P. Yatsenko, and L. K. Rogova. Metalloved. i Term. Obrabotka Metal., No. 6, 12-15(June 1964). (In Russian)

Results are presented from studies of the microstructure, hardness, and microhardness of Be–Nb alloys with 58 wt % (11.6 at.%) Nb annealed and tempered at 850°C. (R.V.J.)

37714 ARSENIDES AND ANTIMONIDES OF NIOBIUM. Sigrid Furuseth and Arne Kjekshus (Universitetet, Oslo). Nature, 203: 512(Aug. 1, 1964).

Phase relations in the systems Nb–As and Nb–Sb were studied by x-ray methods. Density determinations and magnetic susceptibility measurements were carried out. The existence of the Nb_3Sb phase was confirmed, and the occurrence of three other previously unknown phases, the Nb_5Sb_4, $NbAs_2$, and $NbSb_2$ phases, was established. Data on lattice dimensions and observed densities and space groups and parameters are tabulated. NbAs, $NbAs_2$, and $NbSb_2$ were found to have diamagnetic susceptibilities, whereas Nb_3Sb and Nb_5Sb_4 show weak temperature independent paramagnetism. (P.C.H.)

37715 SPECIFIC HEAT AND MAGNETIC SUSCEPTIBILITY OF SUPERCONDUCTING BINARY COMPLEX PHASES OF TRANSITION METALS. E. Bucher, F. Heiniger, and J. Mueller (Eidgenossische Technische Hochschule, Zurich). Physik Kondensierten Materie, 2: 210-40 (1964). (In German)

Measurements of the electronic specific heat in the normal and superconducting state of 15 superconducting binary complex phases of the σ- and χ-structure are presented. The alloys were prepared under high vacuum in an electron-beam melting apparatus described in detail. In the investigated range between 6 and 7 valence-electrons, the obvious correlation between T_c, the superconducting critical temperature, and γ, the coefficient of the electronic specific heat, leads to agreement with the empirical rules. With previously calculated values of the deviation of the normal isotope-effect it was possible to relate the observed T_c-data for most of the transition metal alloys investigated so far to the density of states at the Fermi level and to a systematically varying electron-phonon interaction parameter. In the superconducting state, an exponential dependence of the electronic specific heat on 1/T was found in the range between $T_c/2$ and $T_c/6$. However the parameters are somewhat different from those predicted by theory. The values of γ observed also account for the lack of any correlation between the total magnetic susceptibility and the superconducting critical temperature for these phases. 113 references are included. (auth)

37716 THERMAL EXPANSION OF METALS AT LOW TEMPERATURES. K. Andres (Eidgenossische Technische Hochschule, Zurich). Physik Kondensierten Materie, 2: 294-333(1964). (In German)

The thermal expansion coefficients in the temperature region between 1.5 and 12°K were measured for Al, Pb, Pt, Mo, Ta, W, Mg, Cd, Re, Ti, La, Ce, Nd, Gd, and Yb. Except for tantalum all the specimens were polycrystalline. It was found in accordance with theoretical prediction that the coefficient of thermal expansion $\beta = 1/V(\partial V/\partial T)$ [where V = volume, T = temperature] at sufficiently low temperatures is composed of an electronic component varying linearly with temperature and a lattice component varying as the cube of the temperature. The electronic component was strongly modified in the superconducting state (Pb, Ta, La). The rare earth metals Gd, Ce, and Nd have negative anomalies in their expansion. These are connected with the ferro- and antiferromagnetism of these substances. The results are discussed on the basis of lattice dynamics and the theory of electrons in metals. (auth)

37717 STRESS RECRYSTALLIZATION OF PYROLYTIC GRAPHITE. A. W. Moore, A. R. Ubbelohde, and D. A. Young (Imperial Coll. of Science and Tech., London). Proc. Roy. Soc. (London), Ser. A, 280: 153-69(July 21, 1964).

Graphite as deposited by cracking hydrocarbons around 2000°C shows marked preferred orientation with consequent anisotropy, but still contains numerous structural defects. Procedures were investigated for removing these by recrystallization around 3000°C under a shearing stress, resulting from applying uniaxial pressures of about 400 atm to cylindrical specimens. Subsequent annealing at

around 3400°C under light confinement yields blocks of graphite whose crystal properties are comparable with those of small natural single crystals, as indicated by various tests. (auth)

37718 ELECTRICAL PROPERTIES OF RARE-EARTH MONOCHALCOGENIDES (CERIUM SUBGROUP). V. P. Zhuze, A. V. Golubkov, E. V. Goncharova, and V. M. Sergeeva (Semiconductor Inst., Leningrad). Soviet Phys.-Solid State (English Transl.), 6: 205-12(July 1964). (Translated from Fiz. Tverd. Tela, 6: 257-67(Jan. 1964).

The compounds LaS, CeS, PrS, NdS, LaSe, CeSe, PrSe, NdSe, LaTe, CeTe, PrTe, and NdTe were synthesized. Their temperature dependences of resistivity and thermo-emf in the interval 300–1300°K were investigated. Thermal conductivity was measured at room temperature. It was found that La, Ce, Pr, and Nd monochalcogenides have metallic conductivity. (auth)

37719 ELECTRICAL PROPERTIES OF SmS. V. P. Zhuze, A. V. Golubkov, E. V. Goncharova, T. L. Komarova, and V. M. Sergeeva (Semiconductor Inst., Leningrad). Soviet Phys.-Solid State (English Transl.), 6: 213-16(July 1964). (Translated from Fiz. Tverd. Tela, 6: 268-71(Jan. 1964).

Samarium monosulfide SmS was synthesized. The electric conductivity and thermo-emf of a number of samples were measured in the interval 80–1700°K. The hypothesis is advanced that electrons of the incomplete 4f shell in samarium ions may play an active role in transport phenomena in the given compound. (auth)

37720 INVESTIGATION OF THE STRENGTH OF NEEDLE-LIKE TUNGSTEN CRYSTALS. L. N. Aleksandrov and A. N. Kogan (Mordovian State Univ., Saransk, USSR). Soviet Phys.-Solid State (English Transl.), 6: 246-7(July 1964). (Translated from Fiz. Tverd. Tela, 6: 307(Jan. 1964).

The mechanical properties of needle-like W crystals were studied. Measurements of the microhardness perpendicular to the direction of growth gave a value of 354 kg/mm^2, which is characteristic of W single crystals. The strength of adherence of a needle-like crystal to the filament on which it grew was also investigated. For many needles the adherence strength was low. When the crystal lattice of the needle was evidently a direct continuation of the matrix lattice of the filament, the breakoff strength was substantial and depended on the diameter. (P.C.H.)

37721 ELECTRIC RESISTANCE OF THIN AND THICK GADOLINIUM SPECIMENS AT 2 TO 290°K. E. V. Talalaeva, L. A. Chernikova, and O. S. Galkina. Vestn. Mosk. Univ., Ser. III, Fiz. Astron., No. 2, 82-4(Mar.-Apr. 1964). (In Russian)

The temperature dependence curves of the electric conductivity of massive gadolinium and its thin foils were plotted in order to determine the effects on the θ transition at 210°K. (R.V.J.)

37722 EFFECTS OF POLYGONIZATION ON MOLYBDENUM AND ITS ALLOYS. Shu-sung Tang and M. L. Bernshtein. Wu Li Hsueh Pao, 20: 528-39(June 1964). (In Chinese)

The process of polygonization of molybdenum and its alloys was investigated by means of an electron microscope and metallographic methods. The conditions for polygonization and its growth are explained. The results confirm the effect of polygonization in impeding the process of recrystallization. The effects of polygons on the mechanical properties of molybdenum and its alloys were investigated by measuring hardness and the elastic limit. Results show that the presence of polygon structures improves the strength properties. (tr-auth)

37723 MX_2-COMPOUNDS OF ALKALINE-EARTH AND RARE-EARTH METALS WITH GALLIUM, INDIUM, AND THALLIUM. A. Iandelli (Università, Genoa). Z. Anorg. Allgem. Chem., 330: 221-32(July 1964). (In German)

Some intermetallic compounds of the formula MX_2 of Ca, Sr, Ba, Sm, Eu, and Yb with Ga, In, and Tl were prepared and studied by means of x-rays. Magnetic measurements on these compounds show that europium and ytterbium are divalent. (auth)

37724 KERAMISCHE OXYDSCHMELZEN ALS LOSUNGSMITTEL FUR DEN SPALTSTOFF HOMOGENER HOCHTEMPERATUR-KERNREAKTOREN. (Ceramic Oxide Melts as Solvents for the Fuel of Homogeneous High-Temperature Nuclear Reactors). Klaus Johannsen. Thesis, Berlin, Technische Universität, 1963. 42p.

The suitability of ceramic oxide melts as solvents for the fuel of homogeneous high temperature reactors was investigated. The results show that ceramic oxide melts can often be used as fuel solvents. For temperatures to 1600°C, borate melts of ^{11}B with the addition of BeO, $^{7}Li_2O$, and MgO and for temperatures from 1700°C to 2200°C melts of BeO–MgO or BeO–MgO–Al_2O_3 were suitable. The limiting temperatures given are dependent on the chemical and physical stability of the melts. Since the heat transport in the melts at the high temperatures desired occurs mainly by heat radiation, a low fuel concentration (UO_2) is desirable, which can be attained with the solvents proposed. (tr-auth)

37725 THE RELATION BETWEEN THE STRUCTURE AND MECHANICAL PROPERTIES OF METALS. VOLUMES I AND II. Proceedings of the Conference Held at the National Physical Laboratory, Teddington, Middlesex on 7th, 8th and 9th January, 1963. National Physical Laboratory Symposium No. 15. London, Her Majesty's Stationery Office, 1963. 794p. £3 0s. 0d.

Thirty-four papers are included; separate abstracts were prepared for 4. The remaining 30 papers not abstracted in NSA include information on mechanical properties of simple and complex metals, yielding and friction stress, and applications. (P.C.H.)

For abstracts of individual papers see: 37726, 37727, 37728, and 37729.

37726 THE PRECIPITATION OF NIOBIUM CARBIDE IN AUSTENITIC CREEP-RESISTING STEELS. F. B. Pickering (United Steel Co., Sheffield, Eng.). p.397-407 of "The Relation Between the Structure and Mechanical Properties of Metals. Vol. I." London, Her Majesty's Stationery Office, 1963.

A detailed examination was made on the precipitation sequences and also of the effects of solution treatment temperature on the occurrence of stacking fault precipitation of NbC in 18 Cr-13 Ni 1 Nb (type 347) steel and also a complex austenitic steel containing 16% Cr, 10% Ni, 6% Mn, 1% Mo, 1% Nb, ½% V and boron. Both steels contained 0.08–0.10% C. The results showed that the precipitation of NbC on stacking faults appears to be associated with the increased solubility of NbC resulting from high solution treatment temperatures. The fact that the stacking faults are not present before aging, but only form after aging at

above about 600°C is significant and suggests that they are caused by a diffusion process occurring during aging. The two types of stacking faults that apparently occur probably form by different mechanisms. (P.C.H.)

37727 THE VARIATION OF FLOW STRESS WITH SUBSTRUCTURE IN TANTALUM. D. Hull, I. D. McIvor, and W. S. Owen (Univ. of Liverpool). p.595-612 of "The Relation Between the Structure and Mechanical Properties of Metals. Vol. II." London, Her Majesty's Stationery Office, 1963.

Studies were made on the effects of temperature, grain size, and substructure on the change in dislocation density and distribution with plastic strain in Ta, and the relation of these changes to the change in flow stress with strain. In all the specimens studied, it was found that as the deformation increased the grain boundaries became thicker and more fuzzy due to dislocations either accumulating at or being generated from the boundary. However, it is unlikely that these dislocations are formed by the blocking of a slip band because where this occurs the new dislocations are readily identified. The variation of flow stress with dislocation density is discussed. (P.C.H.)

37728 THE RELATION BETWEEN STRUCTURE AND MECHANICAL PROPERTIES IN THE DEVELOPMENT OF NEW HIGH-TEMPERATURE ALLOYS. M. K. McQuillan and P. V. M. Clark (Imperial Metal Industries (Kynoch) Ltd., Birmingham, Eng.). p.737-64 of "The Relation Between the Structure and Mechanical Properties of Metals. Vol. II." London, Her Majesty's Stationery Office, 1963.

Problems in the development of high-temperature alloys are discussed. Special attention is given to the relation between structure and mechanical properties of the alloys. Application of the theory that the best course for the development of new high-temperature alloys is to use existing theories as a guide in the analysis of experimental data and the selection of the most potentially rewarding lines of further study is illustrated. Commercial alloys are also discussed. (P.C.H.)

37729 THE RELATIONSHIP BETWEEN PHYSICAL STRUCTURE AND HIGH-FIELD SUPERCONDUCTIVITY. J. J. Hauser and J. E. Kunzler (Bell Telephone Labs. Inc., Murray Hill, N. J.). p.765-89 of "The Relation Between the Structure and Mechanical Properties of Metals. Vol. II." London, Her Majesty's Stationery Office, 1963.

Developments in the understanding of the relation between the physical state of the material and its high-field superconducting properties are reviewed. Understanding of the relation should provide considerable information concerning the mechanical properties of materials. (P.C.H.)

Radiation Effects

Refer also to abstracts 37503, 37633, 37676, and 38373.

37730 (A/CONF.28/P/17) UO_2 PERFORMANCE—THE IMPORTANCE OF TEMPERATURE DISTRIBUTION. J. A. L. Robertson, A. S. Bain, J. R. MacEwan, and M. J. F. Notley (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.). May 1964. 13p.

The performance of sintered UO_2 under irradiation testing is discussed, and the effect of the temperature distribution on this performance is considered. Structural changes, the release of fission-product gases, and thermal expansion are also discussed. (C.E.S.)

37731 (A/CONF.28/P/19) FISSION-GAS BEHAVIOR IN UO_2 FUEL. W. B. Lewis, J. R. MacEwan, W. H. Stevens, and R. G. Hart (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.). May 1964. 15p.

Extensive irradiations of high-density sintered UO_2 were carried out in high-pressure loops. Studies were made of fission product retention. Escape mechanisms, sorption, distribution of retained fission products, and fission-gas pressure during irradiation are discussed. (C.E.S.)

37732 (A/CONF.28/P/21) IRRADIATION EXPERIENCE WITH ZIRCALOY-2. W. R. Thomas, S. B. Dalgaard, W. Evans, V. Fidleris, G. W. Parry, and P. A. Ross-Ross (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.). May 1964. 15p.

The effects of neutron irradiation on corrosion and hydriding rates, on creep, and on the mechanical properties of hydrided material were studied for the fuel cladding and pressure tubes of NPD and CANDU. (R.E.U.)

37733 (A/CONF.28/P/62) BEHAVIOR OF URANIUM UNDER IRRADIATION. Yves Adda, Jean-Pierre Mustelier, and Yves Quere (France. Commissariat a l'Energie Atomique, Paris). May 1964. 15p.

The main results obtained in a study of the formation of defects caused in uranium by fission at low temperature are reported. By irradiation at 20°K it was possible to determine the number of Frenkel pairs produced by one fission. Irradiations at 77°K gave additional information, showing behavior differences in the case of recrystallized and cold worked uranium. The diffusion of rare gases was studied using metal-rare gas alloys obtained by electrical discharge, and samples of irradiated uranium. It was shown that a small addition of molybdenum could reduce the diffusion coefficient by a factor of 100. The important part played by dislocations in the generation and growth of bubbles was demonstrated, and it was shown also that precipitation of bubbles on the dislocation lattice could block the development of recrystallization. The results of these studies were compared with observations made on the swelling of uranium alloys. In the case of uranium the bubbles are either distributed at random, or grouped in flat accumulations which can give rise to transgranular cracks, according to the state of the metal and the irradiation temperature. At high temperature an intergranular decohesion is also observed. (auth)

37734 (A/CONF.28/P/92) A NEW ORDERED STRUCTURE CREATED BY NEUTRON IRRADIATION. Louis Neel, et al. (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 2p.

The establishment of equilibrium in a crystal lattice upon neutron irradiation is discussed. The density of holes is considered. (R.E.U.)

37735 (A/CONF.28/P/97) THE EFFECT OF NEUTRON IRRADIATION ON CERTAIN FUELS USED IN GAS-GRAPHITE TYPE REACTORS. Marcel Englander, et al. (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 15p.

Experimental fuel elements made from uranium alloys containing only traces of added elements or containing 0.5 to 3.0% Mo were irradiated in the French reactors EL3, G2, and G3 at temperatures of 150 to 600°C. The results of

observations and measurements on the elements are presented. (D.C.W.)

37736 (A/CONF.28/P/145) THE IRRADIATION BEHAVIOUR OF URANIUM AND URANIUM ALLOY FUELS. R. S. Barnes, R. G. Bellamy, B. R. Butcher, and P. G. Mardon (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). May 1964. 14p.

Basic mechanisms for the two irradiation-induced phenomena of growth and swelling have been proposed. Growth is ascribed to the selective condensation of vacancies and interstitial atoms in preferred crystallographic planes under the anisotropic thermal expansion stresses in the "fission spikes," and it has been deduced that growth effects persist to higher temperatures with increasing fission rate. It has been proposed that swelling due to irradiation-produced inert gases in uranium is governed largely by surface diffusion of the metal atoms, which allows the bubbles to migrate bodily and to collide and coalesce with one another. Theories based on this mechanism can account for breakaway swelling and grain boundary phenomena and do not require any re-solution of the inert gases. During capsule irradiation tests, pure uranium swelled badly in the temperature range 500 to 650°C. Small additions of carbon, molybdenum, and aluminum reduced the swelling, while iron, chromium, titanium, and niobium had no significant effect. The lowest swelling occurred in "adjusted" uranium, i.e., the product containing 200 to 500 ppm iron, 500 to 1200 ppm aluminum and 300 to 1200 ppm carbon, beta-quenched and alpha-annealed to achieve small random grains which minimize irradiation growth and surface wrinkling. It contained a fine intermetallic precipitate, primarily UAl_2. After comparable irradiations the gas bubbles were much smaller and more numerous than those in pure uranium, and since the pressure in small bubbles is high, the volume increase was less. The fine precipitate is believed to be responsible for the small bubble size and superior swelling resistance, probably by preventing the migration of the bubbles. The thermal cycles to be expected in a "Magnox" reactor do not affect the swelling resistance of "adjusted" uranium. Enhanced swelling, due to large grain boundary fissures, was observed in alpha-uranium irradiated at 400 to 500°C and at fission rates of 15 Mw/t or more. This has been called enhanced grain boundary swelling and is believed to be due to irradiation growth stresses probably acting in conjunction with the grain boundary bubbles to produce large tears. "Adjusted" uranium was again found to be superior to pure uranium in resisting this effect, which is not significant at the low fuel ratings used in the "Magnox" reactors as the growth stresses do not persist to sufficiently high temperatures. Uranium/plutonium/molybdenum alloys irradiated in the gamma-phase at 600°C showed increasing swelling with increasing plutonium or decreasing molybdenum content. However, although the swelling was low compared with pure uranium, the best uranium/plutonium/molybdenum alloy was inferior to "adjusted" uranium. It is concluded that "adjusted" uranium shows excellent resistance to irradiation growth and swelling, which it achieves with only minor additions and without the large nuclear and chemical processing penalties associated with more highly alloyed uranium. It is considered that the irradiation characteristics of this "adjusted" uranium will not limit the life of the present "Magnox" fuel below 5000 Mwd/t average. (auth)

37737 (A/CONF.28/P/148) POST-IRRADIATION EXAMINATION OF C.E.G.B. FUEL ELEMENTS. G. W. Greenwood and B. F. Sharpe (Gt. Brit. Central Electricity Generating Board, London). May 1964. 15p.

The aim of our examination is twofold: to assist the reactor operator in the elimination of reactor shut-down, which may be due to perforations in the fuel element can or physical change in the fuel element, either of which may adversely affect the operation of the reactor, or impede discharge from the reactor; and secondly, to provide information on the condition of the heat transfer surfaces of the can together with the extent of deformation of the uranium bar. Upon such data, reactor operation and the future design of fuel elements can be based. The techniques of remote handling, dismantling, and examination of fuel elements, which have been established to ensure that the maximum amount of information is obtained from a minimum number of remote operations, are described. Attention is drawn to the ability resulting from the use of simple equipment, to change the emphasis of the examination. Methods of optical examination are outlined and illustrations are given of the way in which deformation of fuel element components and the external surface of the can is assessed. The extent to which radiography can provide useful information is discussed and it is shown that precise measurements of fuel bar distortion can be made from radiographs when the geometry of projection from a point source is taken into account. The requirements for leak detection in irradiated fuel elements are considered and it is shown that the ideal is most nearly achieved by bubble leak location, which involves reducing the pressure above the surface of a liquid in which the element is immersed. Developments of this method permit the assessment of leak size and shape. A description is given of techniques of sectioning fuel elements for metallographic examination, whereby distortion of the specimen is minimized. Facilities for investigating the properties of fuel element materials are described and illustrated by examples of work currently in progress. The problems of maintenance, decontamination, and waste disposal, as they affect laboratory practice, are briefly discussed. Specific mention is made of a process for converting the swarf from machining operations into inert glass blocks. (auth)

37738 (A/CONF.28/P/155) THE BEHAVIOUR OF UO_2 AND OF $(U,Pu)O_2$ FUEL MATERIALS UNDER IRRADIATION. L. E. J. Roberts (United Kingdom Atomic Energy Authority Research Group. Atomic Energy Research Establishment, Harwell, Berks, England), P. Brock, J. R. Findlay, B. R. T. Frost, L. E. Russell, J. B. Sayers, and E. Wait. May 1964. 15p.

Results are given of several recent studies of the course of radiation damage in oxide fuel materials and of pre-irradiation characterization of $(U,Pu)O_2$ solid solutions. Thermodynamic and crystallographic data indicate that single-phase solid solutions are preserved under strongly reducing conditions, and also under mildly oxidizing conditions at high temperatures, if the ratio $Pu/(U + Pu) \leq 0.35$. The thermodynamic results are used to discuss the precise composition reached by oxides during preparation and in use and the chemical form of the fission products. Crystallographic evidence indicates the formation of stable clusters of defects at doses of 5×10^{18} fissions/cm^3 during irradiation at 70°C and at 400°C; most of the damage anneals in several stages between 200 and 700°C. Volatile fission products – I, Te, and Cs – move as fast or faster through sintered UO_2 at 1400°C as do rare gas atoms; the introduction of Pu has little intrinsic effect on

gas emission. Electron microscopy reveals the migration of pores to grain boundaries during irradiation. The evidence is consistent with the concentration of fission products at grain boundaries, even at low temperatures. Radial temperature gradients have been measured during irradiation; thermal conductivity (K) values do not change appreciably at doses up to 5×10^{19} fissions/cm^3 and mean temperatures of above 500°C, but K values decrease during irradiation at lower temperatures. Miniature fuel elements of UO_2 have been irradiated to burn-ups of 2 to 5.7% over a range of center and surface temperatures. Fission gas release varied from 0.2 to 68% but no gross dimensional changes were observed. Evidence of some plastic flow was obtained during irradiation to 5.7% burn-up at estimated temperatures lower than 1300°C. The behavior of $(Pu_{0.01}U_{0.99})O_2$ solid solutions has been compared with that of UO_2 in irradiations at low burn-up and center temperatures up to 2300°C, and $(Pu_{0.10}U_{0.90})O_2$ was tested along with UO_2 to a burn-up of 0.9% at center temperatures below 1275°C. The introduction of Pu had no deleterious effect in either case; gas release was similar for the UO_2 and $(U,Pu)O_2$ oxides and the $(Pu_{0.1}U_{0.9})O_2$ pellets were less cracked than the UO_2 pellets. (auth)

37739 (A/CONF.28/P/162) IRRADIATION BEHAVIOUR OF STEEL AS A STRUCTURAL AND CLADDING MATERIAL. D. R. Harries (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). K. Q. Bagley, I. P. Bell, W. S. Gibson, J. Gillies, P. C. L. Pfeil, and S. B. Wright. May 1964. 14p.

Ferritic-steel tensile specimens, irradiated at controlled temperatures in the range of 100 to 350°C in a series of reactor spectra, were tested at room temperature and the effects on the lower yield stresses determined. The magnitudes of the radiation hardening are a function of the neutron dose, irradiation temperature, neutron spectrum, and type of steel, but are independent of the neutron dose rate. The hardening is a maximum after irradiation at 100°C, and decreases after irradiation at higher temperatures due to annihilation or redistribution of the point defects. The effects of neutron spectrum were analyzed in terms of various models of radiation damage and the results used to predict the irradiation embrittlement of the Calder Hall pressure vessel steel over the life-time of the reactor. After 5 years operation, the predicted increase in ductile-brittle transition temperature is about 5°C regardless of the model used; this is consistent with the results of tests on monitoring specimens exposed adjacent to the pressure vessel and removed after 5 years operation of the reactor. Comparison of the irradiation embrittlement in thick plate and small specimens shows that no significant specimen size effect exists. The effects of neutron irradiation are to increase the proof and ultimate stresses and to reduce the ductility of austenitic steels in post-irradiation tensile tests at temperatures below about 500°C. These changes in properties can be correlated with the fission (or fast) neutron dose and result from the introduction of point defects into the lattice by fast neutron-atom collisions. Further reductions in tensile ductility are obtained on testing the irradiated austenitic steels at temperatures above about 650°C. This high temperature loss in ductility is a function of the thermal neutron dose and the magnitude of the effect is independent of the irradiation temperature. The reduction in ductility is probably due to the formation of the precipitates that were observed on the dislocations and at the grain boundaries in the irradiated specimens. Pre-treatment of austenitic steels, involving precipitating as much as possible of the carbon and nitrogen out of solution in the steel and refining the grain size, reduces the magnitudes of the high-temperature loss in ductility in post-irradiation tensile and stress-rupture tests. The reduction in ductility is not due to irradiation enhanced diffusion but to a thermal neutron induced transmutation effect; preliminary results suggest that the products of the $^{10}B(n,\alpha)^7Li$ reaction are either directly or indirectly responsible for the effects observed. (auth)

37740 (A/CONF.28/P/163) THE IRRADIATION BEHAVIOUR OF GRAPHITE. J. H. W. Simmons (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England), B. T. Kelly, P. T. Nettley, and W. N. Reynolds. May 1964. 15p.

Experimental results on the effects of irradiation on graphite in the temperature range 150 to 650°C are described. Samples of Grade A reactor graphite have been irradiated in high flux reactors and measurements made of the changes in thermal conductivity, thermal expansion, Young's modulus, and dimensions. The changes in thermal expansion and dimensions of pyrolytic graphite were also measured. It is considered that the results give a good representation of the behavior of the crystals of which reactor graphite is composed. The dimensional changes of pyrolytic graphite are compared with values for the dimensional changes of graphite crystals, inferred from measurements on reactor graphite. The results of work on the structure of radiation defects in graphite are summarized. Thin film electron microscopy yielded a considerable amount of direct information on the properties of large interstitial clusters, and some of the properties of vacancies and small interstitial clusters can be inferred. The results of the irradiation experiments are interpreted in terms of a radiation damage model, formulated on the basis of information on defect structures. This work extends the data on the behavior of reactor graphite over a sufficiently wide range of temperature and dose to cover almost the complete life of the reactors in the first stage of the United Kingdom's power program. Understanding of the mechanisms involved has enabled methods of allowing for differences in temperature and flux level to be developed. (auth)

37741 (A/CONF.28/P/167) NEUTRON INTERACTIONS WITH REACTOR MATERIALS. E. R. Rae (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England), R. Batchelor, P. A. Egelstaff, and A. T. G. Ferguson, May 1964. 15p.

The UKAEA program of measurements of neutron interactions with fissile, fertile, moderator, coolant, and structural materials is discussed in the light of reactor physics demands. The reasons behind the measurements and the extent of the program are summarized. The experimental work on typical examples of each of the categories mentioned, namely uranium-235, uranium-238, iron, and water, is described. The section on uranium-235 describes measurements of the fission cross section in various neutron energy regions from thermal to 14 Mev. The variation of the quantities $\bar{\nu}$ and η with neutron energy is presented, the former over a wide energy range and the latter in the resonance region. A determination of the total cross section up to 80 kev is also given, from which s and p-wave strength functions and the absorption cross section are deduced. The work on ^{235}U is illustrated by studies of the

capture cross section throughout the energy range from a few ev to 14 Mev and of inelastic scattering from threshold to 4 Mev. Recent improvements in technique permit the construction of much more complete energy level schemes for the ^{238}U nucleus. Nuclear inelastic scattering in iron is also described in the energy range 1 to 4 Mev and optical model fits are given to the data. Cross sections and spectra for the emission of γ rays following inelastic scattering are described, and the capture cross section below 100 kev is briefly discussed. The scattering of thermal neutrons by bound nuclei is studied. The results of measurements do not contain the complete information required for reactor calculations and must be supplemented by theoretical considerations based on suitably chosen models of the moderator materials. The data for water at different temperatures are presented and compared with several theoretical models. (auth)

37742 (A/CONF.28/P/338) BEHAVIOUR OF NUCLEAR FUEL UNDER IRRADIATION (INVESTIGATION OF THIN LAYERS OF IRRADIATED URANIUM DIOXIDE). V. M. Golyanov and N. F. Pravdyuk (U.S.S.R.). May 1964. 20p.

The effects of irradiation on uranium dioxide were investigated by electron microscopy of thin films. Annealing of defects, the nature and formation of defects, fission gas formation, and the relation of radiation dose to defect concentration were considered. (D.C.W.)

37743 (A/CONF.28/P/338a) THEORY OF FISSILE MATERIALS SWELLING. V. M. Agranovich, E. Y. Mikhlin, L. P. Semionov, V. I. Pupko, Y. I. Likhachev, and V. P. Zvonarev (U.S.S.R.). May 1964. 16p.

The swelling of fissile materials due to solid fission products and due to formation of gaseous pores is discussed, and the mechanisms of the gaseous swelling are considered in more detail. The theory of gaseous swelling is given, and asymptotic solutions are given for the equations for the volume increase. Movement of the gaseous pores is considered. Finally, the question of internal stresses due to nonuniform swelling is discussed. (D.L.C.)

37744 (A/CONF.28/P/338b) BEHAVIOUR OF NUCLEAR FUEL UNDER IRRADIATION. N. F. Pravdiuk, S. M. Astrakhantsev, K. P. Dubrovin, E. G. Ivanov, and V. I. Karpuhin (U.S.S.R.). May 1964. 16p.

The effects of reactor irradiation on UO_2 compacts, UO_2 in Cu, Mo–U alloy, alpha uranium, and uranium compounds in aluminum matrix were investigated. (D.C.W.)

37745 (A/CONF.28/P/339) STUDY OF TENDENCY TO BRITTLENESS OF FERRITE–PEARLITE STEELS FOR REACTOR VESSELS DURING NEUTRON IRRADIATION. A. D. Amaev, P. A. Platonov, and N. F. Pravdyuk (U.S.S.R.) May 1964. 21p.

Effects of neutron irradiation on the mechanical properties of low-carbon and low-alloy steels and their welded joints used for making power reactor vessels were studied. The effect of the integrated flux and irradiation temperature on strength and brittleness and the effect of postirradiation annealing on the recovery of steel mechanical properties were considered. Steel strengthening by neutron irradiation depends not only on the temperature and radiation dose but also on steel composition. The irradiation temperature is the main factor determining the stability of properties of the irradiated samples. The critical temperature of brittleness as measured during shock or static bendings is a basic characteristic for evaluation of safety operation of the reactor vessel material. Theoretical evaluation of spectrum influence on steel strengthening is given. The product of multiplying numbers with reduced density by their effective size is considered to be a criterion of damage. (M.J.T.)

37746 (A/CONF.28/P/339a) EFFECT OF REACTOR IRRADIATION ON STRESS-RUPTURE STRENGTH OF AUSTENITIC STEELS AND HEAT-RESISTANT MATERIALS BASED ON IRON AND NICKEL. E. V. Gusev, P. A. Platonov, N. F. Pravdyuk, and N. M. Sklyarov (U.S.S.R.). May 1964. 16p.

Six steel alloys and commercial nickel were irradiated in the fuel channels of the reactor PFT with integrated fluxes of (1 to 3) $\times 10^{20}$ n/cm^2 at temperatures of 150 to 200, 450, and 550°C. Radiation effects on tensile strength, stress-rupture strength, hardness, creep strength, and microstructure were studied; measured stress and hardness are presented as functions of test temperature from 20 to 800°C for the studied materials. It was found that reactor irradiation causes significant changes in mechanical properties of heat resistant alloys based on iron and nickel and of austenitic chromium–nickel steels. At high test temperature, starting at 500 to 600°C, the plasticity and strength of the alloys decrease considerably. (M.J.T.)

37747 (A/CONF.28/P/398) IRRADIATION BEHAVIOR OF COATED FUEL PARTICLES. H. Bildstein, A. Burtscher, P. Koss, and F. P. Viehboeck (Osterreichische Studiengesellschaft fur Atomenergie G.M.B.H., Seibersdorf, Austria). May 1964. 17p.

The behavior of coated fuel particles under reactor conditions was investigated in a series of capsule tests performed in the ASTRA reactor at thermal flux levels of 3 to 6×10^{13} n/cm^2 sec. The burnup achieved was about 10% at operating temperatures of 1200 to 1400°C. Two types of capsules were used. One employed a graphite insert which was thermally insulated against the stainless steel containment by a helium gap. The other type utilized a niobium insert thermally insulated by Al_2O_3 powder. Both inserts contained the particles in an annular gap. The fuel temperature was monitored by high temperature thermocouples located at both sides of the fueled annulus. With this arrangement, data on the thermal conductivity of a loose packing of coated particles were obtained. After dismantling the capsules in the hot cell, the burnup was determined by evaluation of cobalt dosimeters and by mass-spectrometric analysis of the uranium isotopes. This measurement was performed by using a high-temperature ion source in which the uranium ions were obtained by surface ionization after a volatilization by a halogen treatment. After a visual inspection and a metallographical examination, the integrity of the particles was checked by two methods. The first utilized a xenon release measurement on reactivated particles to obtain the number of failed particles. The second used a chlorination process which allows the quantitative removal of uranium from failed particles via the volatile chloride. By analyzing the insert of the capsule, the amount of nongaseous fission products released during the experiments was determined by radiochemical methods and, in some cases, by gamma spectrometry. The results of the high temperature burnup tests are given and correlated with the results of a preirradiation evaluation of coated particles produced by different methods. (auth)

37748 (A/CONF.28/P/412) MICROSTRUCTURE AND GRAIN SIZE EFFECTS ON IRRADIATION HARDENING

OF LOW CARBON STEEL FOR REACTOR TANKS. N. Milasin (Institut za Nuklearne Nauke "Boris Kidric," Belgrade). May 1964. 17p.

The experiments described were performed to give a new evidence on the influence of the grain size parameter on irradiation hardening of a given type of low carbon steel for the reactor tank at integral fast flux $>10^{19}$ nvt and irradiation temperature below 100°C. At the same time the experimental procedures used to obtain different grain size specimens gave different microstructures of the steel. Thus, it was necessary to deal not only with different grain sizes, but also to take into account possible influence of the microstructure obtained. Actually, it was found that the behavior of the specimen during irradiation was more affected by microstructure than by grain size. The most important results obtained could be summarized as to indicate: (1) different grain size specimens having ferrite-pearlite microstructure gave the same increase in a yield stress, (2) specimens with cemetite precipitated at the grain boundaries have shown a much more pronounced embrittlement; after irradiation all of them fractured in a brittle manner before the plastic region has been reached, (3) the specimens treated in the austenitic range to obtain large grain sizes embrittled less than the specimens deformed at room temperature and treated in the ferritic range, the elongation to fracture being reduced much more in the latter case. This is also followed by a more pronounced change in the shape of the stress-strain curve of the specimens treated in the ferritic range. The annealing experiment was performed at 150°C. In general, ferrite-pearlite microstructure specimens have shown a further small increase of the yield and ultimate tensile stress. It is concluded that the hardening mechanism is very complicated. (D.L.C.)

37749 (A/CONF.28/P/420) IRRADIATION BEHAVIOUR OF SWEDISH STEELS FOR REACTOR PRESSURE VESSELS. H. P. Myers, M. Grounes, and N. E. Hannerz (Aktiebolaget Atomenergi, Studsvik, Sweden). May 1964. 16p.

A systematic study of the effects of irradiation dose (10^{18} to 10^{20} nvt >1 Mev) and irradiation temperature (50 to 300°C) was made on three C–Mn mild steels, including ASTM A212B; three low alloy Mn–Mo steels including ASTM A302B; a B–Mo alloy steel and two versions of a martensitic austenitic 13 Cr–6 Ni steel. These steels were irradiated in the conventional conditions as produced by the manufacturer but, in co-operation with industry, metallurgical variables including the effects of grain size, deformation aging, and quenching and tempering were also considered in certain cases. The irradiation changes in the hardness, impact energy to fracture, and tensile strength of these steels were measured and show different steels, or different conditions of the same steel, to exhibit widely differing susceptibilities to irradiation embrittlement. For this work conventional testing techniques were used, but in addition a miniature Charpy V specimen was developed. This was found to be eminently satisfactory for the irradiation of two or more steels under identical conditions of temperature and neutron flux in rigs of limited volume. This work allows both an assessment of the irradiation behavior of Swedish pressure vessel steels at present available as well as a comparison with certain standard American qualities. The brittle-ductile transition temperature of a pressure vessel steel is affected by factors and treatments other than neutron irradiation, and an assessment of a steel's suitability for use in a reactor vessel must include careful consideration of aspects such as stress relieving, deformation aging, heat affected zones around welds, and the properties of the weld metal. The significance of irradiation effects as well as other metallurgical variables influencing the brittle-ductile transition temperature and affecting the use of steel in reactor pressure vessels are discussed. (auth)

37750 (A/CONF.28/P/430) IRRADIATION TESTS OF UO_2 FUEL: RADIOGRAPHY WITH BETATRON AND NEUTRON; RELOCATION OF FISSION PRODUCTS AND PLUTONIUM. Hiroshi Kamogawa (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Kanagawa Prefecture, Japan), Hiroshi Tomishima, Hatsutaro Nagami, Kazuyuki Ogawa, Noboru Oi, Nobuyoshi Wakabayashi, Tadao Ohno, and Keiji Naito. May 1964. 16p.

Natural uranium UO_2 pellets fabricated by the roll method were irradiated in the GETR at high temperature (~2000°C at the surface and ~3000°C at the center) and at lower temperatures (~900°C at the surface and ~1500°C at the center). A method for radiography of the specimens using betatron x rays was developed that provided clear, high-resolution radiographs. Neutron radiography was also applied. The distributions of fission products and plutonium in the irradiated specimens were examined in detail. (D.C.W.)

37751 (A/CONF.28/P/443) IRRADIATION OF PLUTONIUM-ENRICHED CERAMIC FUEL RODS IN THE BR 3 POWER REACTOR. J. M. Leblanc (Centre d'Etude l'Energie Nucleaire, Brussels). May 1964. 19p.

Twelve plutonium–uranium oxide fuel rods were introduced in the Belgian BR 3 reactor. The main objective of this experiment was to raise and to solve the technological problems concerning the fabrication of plutonium enriched fuel rods and to study their behavior under the pressurized water power reactor operation conditions. The fuel rods were prepared by vibratory and swaging compaction of physically mixed dense UO_2 and UO_2–PuO_2 powders. (auth)

37752 (A/CONF.28/P/460) ON THE LONG-TERM MECHANICAL PROPERTIES OF METALS USED AT ELEVATED TEMPERATURES AND SUBJECTED TO NEUTRON IRRADIATION. W. Siegfried and S. Zimering (Battelle Memorial Inst. International Div., Geneva). May 1964. 19p.

The extrapolation of creep tests under neutron radiation was investigated. It was found not only that extrapolation methods can be used under neutron irradiation but also that present extrapolation methods without neutron irradiation can be improved. (D.C.W.)

37753 (A/CONF.28/P/470) INFLUENCE OF VARIOUS PARAMETERS ON THE BEHAVIOUR OF GRAPHITE UNDER NEUTRON RADIATION. M. Beutell and O. Vohler (Siemens-Planiawerke A. G. fllr Kohlenfabrikate, Meitingen, Germany). May 1964. 12p.

The alteration of graphite in dimensions under irradiation is not only defined by the so-called degree of graphitization, the degree of order of the intracrystalline range, but also by the order between the crystallites and the order of the grains within the matrix. However, when observing the intra- and intercrystalline degree of order, the theory may be established that well graphitized graphites (with high microcrystalline degree of graphitization) at high temperature irradiations prove special dimensional stability when they are showing a high coefficient of thermal expansion in the unirradiated state, i.e. when they are

showing as little intercrystalline failures and cracks as possible, into which an expansion could take place. As may be expected, the intergranular order is of decisive influence on the dimensional changes due to irradiation. Thus, irradiations at pool water temperature have shown that shaped graphite bodies with which, by maintaining the raw materials for the filler and binding component, the intergranular order and therewith the anisotropy has been raised only by increased crushing of the grain, show for instance a considerably greater growth of the shaped body in the direction perpendicular to the grain (in the direction of the resultant of the C-axes of the individual crystallites). While the dependence of dimensional changes under irradiation on the grain size is given with certainty, it is, at least for the pool temperature irradiation, not yet possible to make a clear statement on a relation of the growth and shrinking by irradiation to the size of the specimen. (T.R.H.)

37754 (A/CONF.28/P/471) HARDENING OF FACE-CENTRED CUBIC METALS DUE TO REACTOR IRRADIATION. J. Diehl (Max-Planck-Institut für Metallforschung, Stuttgart), and W. Schilling. May 1964. 16p.

A survey on the changes of the mechanical properties of fcc single crystals due to fast neutron irradiation is presented. Information is derived from irradiations at ambient reactor temperature and helium temperatures, normal tensile tests, creep test, measurements with changes in temperature and strain rate and electron microscope studies of slip lines. (auth)

37755 (A/CONF.28/P/490) INVESTIGATION OF COMMERCIAL HYDROCARBON MIXTURES SUITABLE FOR THE MODERATOR-COOLANTS OF NUCLEAR REACTORS. R. Barrera Piñero and J. Manero Rodríguez (Spain. Junta de Energía Nuclear, Madrid). May 1964. 22p.

A study was made of three commercial mixtures of terphenyls (PROGIL OM1, OM2, and OMP) and three mixtures of partially hydrogenated terphenyls (MONSANTO HB-40 and HB-20 and PROGIL OMP-H). The tests were mainly concerned with studying the thermal and radiation behavior of these substances and investigating the effect of thermal and radiolytic damage on their principal physical properties. (auth)

37756 (A/CONF.28/P/726) THE NORWEGIAN-NETHERLANDS' FUEL IRRADIATION EXPERIMENT. R. G. Schoelvinck (Reactor Centrum Nederland, Petten), P. F. Sens, and E. Jensen. May 1964. 16p.

Since 1962 experimental UO_2 fuel irradiations have been performed in a loop in the High Flux Reactor at Petten. The H.F.R. is an enriched uranium fueled, light water cooled, materials testing reactor, operating at a power of 20 MW. The purpose of the experiments is to study the behavior of UO_2 fuel, irradiated at high specific power to a high burn-up. Fuel capsules between 10 mm and 15 mm diameter are contained in a pressure tube, located in one of the beryllium reflector elements, adjacent to the reactor core. The in-pile section is of the re-entrant thimble type. Dependent on location, the effective thermal neutron flux in the fuel capsules is between 0.8 and $1.5 \cdot 10^{14}$ n/cm^{2}sec. Loop equipment and instrumentation are in the basement of the reactor building in a special shielded cubicle. Operation of the loop has been satisfactory so far. Fuel ratings have been achieved up to 750 W/cm fuel length (kdT = 60 W/cm) and fuel exposures in excess of 10,000 Mwd/ton. The post irradiation facilities consist of two lead cells (7'' and 10'' wall thickness) of the box in a cell type. Results of the post irradiation measurements are presented. They include measurements on the change in dimensions of the fuel capsules, on the release of fission gases, on the burnup, on grain growth and further metallographic observations. (auth)

37757 (A/CONF.28/P/735) IRRADIATION EXPERIMENTS ON URANIUM-RICH ALLOYS. G. Colabianchi (Italy. Comitato Nazionale per l'Energia Nucleare, Rome), C. Fizzotti, G. Traversi, J. J. Stobo, and F. Squadrelli-Saraceno. May 1964. 23p.

The behavior of heat-treated adjusted uranium is compared with some molybdenum alloys at two different temperatures, with and without thermal cycling. Special emphasis was placed on the unusual features of exact simulation of the thermal history of each in-pile specimen. The results obtained for grain size effect in adjusted uranium, effect of thermal cycling together, re-crystallization and metallographic changes in the alloys due to thermal and irradiation effects, are reported. (auth)

37758 (ANL-6703(p.518-35)) INVESTIGATION OF SA-212 GRADE B MATERIAL REMOVED FROM THE EBWR PRESSURE VESSEL WALL. (R. E. No. 763). (Memo dated April 24, 1961 by T. L. Kettles). (Argonne National Lab., Ill.).

The mechanical properties of plugs of SA-212 Grade B carbon steel removed from the walls of the EBWR pressure vessel were compared with virgin material. The plugs were taken when the pressure vessel was modified for operation at 100 Mw(t). Tensile and impact tests were performed. (R.E.U.)

37759 (BMI-1683) EFFECT OF SIMULATED IN-REACTOR ANNEALING ON AN IRRADIATED TYPE 347 STAINLESS STEEL PRESSURE TUBE. Mihkel Kangilaski, Frederic R. Shober, and John E. Gates (Battelle Memorial Inst., Columbus, Ohio). July 31, 1964. Contract W-7405-eng-92. 35p.

The effects of a simulated in-pile anneal conducted by Bettis Atomic Power Laboratory on the mechanical properties of an irradiated Type 347 stainless steel pressure tube were studied. The effects of a subsequent 1-hr anneal at 1800°F (982°C) in an annealing furnace were also investigated. The pressure tube operated in the ETR at a maximum temperature of approximately 700°F (370°C) in a stressed condition and accumulated a fast-neutron (>1 Mev) exposure of about 6.6×10^{21} nvt. Tests were carried out at 25 and 400°C. Hardness tests at 25°C showed a wide range of hardness values, 75 to 48 Rockwell A, indicating a non-uniform annealing pattern resulting from the simulated in-reactor anneal. The results of tension tests at 25 and 400°C gave ultimate strengths of 90,000 and 65,000 psi, 0.02 per cent offset yield strengths of 50,000 and 30,000 psi, total elongations of 50 and 25 per cent, and reductions of area of 70 and 60 per cent, respectively, after the anneal. These results are similar to those obtained in a previous investigation following a 1-hour anneal at 1000°F (540°C) and indicate that an in-reactor anneal will remove an appreciable portion of the radiation-induced property changes. A subsequent furnace anneal at 1800°F (982°C) produced additional recovery of radiation-induced property changes. (auth)

37760 (BNL-874(p.6-7)) STUDY OF RADIATION AS A MEANS OF INHIBITING BACTERIA GROWTH IN JP-4 FUEL. S. K. Hellman (Vitro Engineering Co., New York).

The use of radiation is proposed as a means of inhibiting bacteria growth in JP-4 fuel. The use of isotope irradiation should be on a continuous basis rather than on an instantaneous one in order to reduce the irradiator's capacity by a substantial margin. (P.C.H.)

37761 (BNL-874(p.26)) RADIOLYTIC OXIDATION EFFECTS IN OPTICAL MASER MATERIALS. James G. Beckerley and Kalman Held (Radioptics, Inc., Carle Place, N. Y.).

Plans for future efforts aimed at achieving improvements in optical maser materials by means of the oxidation-reduction reactions that occur during exposure to an ionizing radiation source are reported. A wide variety of rare earth salts and other inorganic materials necessary for preparation of tetragonal and monoclinic substrates have been obtained. (P.C.H.)

37762 (BNL-874(p.33-4)) THE INVESTIGATION OF THE EFFECTS OF IONIZING RADIATION ON INDUSTRIAL COLLOIDS. Hal R. Spragg and Harry K. Bjorkman (Universal Match Corp., Ferguson, Mo.).

A program with the prime objective of exploring the effects of ionizing radiation on colloidal systems, in anticipation of demonstrating that the use of radiant energy as a unit process will materially aid in solution of some of the referenced problems, is proposed. Initially, the current program will concentrate on investigation of the effects of ionizing radiation on common industrial colloid forms, such as montmorillonite and similar clays, polystyrene and rubber latexes, and oil-water emulsions. The effects of irradiation on these colloids will be determined by any changes observed in electrophoretic mobility, zeta potential, flocculation value, gold number, particle size stability, sedimentation characteristics, thixotropy, and stability under shear. (P.C.H.)

37763 (EURAEC-1103) INFLUENCE OF NITROGEN IN IRON AND STEEL UNDER FAST NEUTRON IRRADIATION. Quarterly Report No. 3, April 1–June 30, 1964. (Societa Ricerche Impianti Nucleari. Centro Ricerche Nucleari, Saluggia, Italy). Work Performed under United States–Euratom Joint Research and Development Program. Contract 004-63-10-TEEI(RD). 23p.

Samples of iron and steel containing various amounts of carbon, nitrogen, and titanium were prepared and tested in order to study the effects of impurities and additives on the properties and radiation effects on the alloys. (N.W.R.)

37764 (WCAP-3734) FABRICATION AND IRRADIATION OF STAINLESS-STEEL-CLAD UO_2 FUEL RODS. (THE LRD IN-PILE CHEMICAL SHIM LOOP EXPERIMENT). D. R. McClintock and C. J. Kubit (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Apr. 1964. Contract AT(30-1)-3064. 112p.

Seven stainless steel-clad UO_2 fuel rods of the proposed Large Plant geometry were irradiated for various intervals in a borated pressurized water loop to a maximum burnup of 4,000 Mwd/MTU at a maximum heat flux of 340,000 Btu/hr-ft^2. A tungsten/tungsten 26% rhenium thermocouple was used to measure the fuel temperature. Post-irradiation examination revealed no adverse effects related to exposure in the high temperature and high pressure chemical-shim environment. Each of the rods was punctured and the amount of fission gas released was determined. The fission-gas-release data and the fuel temperature measurements were consistent with the fuel microstructures. Test specimens of nickel plated Ag–15 In–5 Cd candidate control rod materials, included as part of the in-loop test assembly, exhibited attack of the electroplated nickel coating. (auth)

37765 (AEC-tr-6398(p.24-33)) INVESTIGATION OF THE CHANGES IN THE PROPERTIES OF SUBSTANCES IN INTENSE FIELDS OF NUCLEAR RADIATIONS. S. V. Starodubtsev. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 26-?(1961).

The mechanisms and effects of interactions of penetrating radiation with matter are discussed. (R.E.U.)

37766 (AEC-tr-6398(p.189-91)) VOLUME DISTRIBUTION OF LATTICE DEFECTS IN CRYSTALS OF GERMANIUM IRRADIATED BY FAST ELECTRONS. L. S. Smirnov and P. Ya. Glazunov. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 153-?(1961).

Defect distribution was studied for germanium following irradiation by electrons at 500 to 900 kev. Effects on conductivity were studied. (R.E.U.)

37767 (AEC-tr-6398(p.192-8)) FORMATION OF ACTIVATION CENTERS IN AN X-RAY RADIOSCOPED SINGLE CRYSTAL OF CdS. O. R. Niyazova and S. V. Starodubtsev. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 155-?(1961).

Processes related to the activation of the crystal, migration of the active agents (excitons), and deactivation were studied experimentally by observing changes in conductivity after infrared and x irradiation. (R.E.U.)

37768 (AEC-tr-6398(p.374-6)) PROCEDURE FOR MEASURING THE ELASTIC PROPERTIES OF IRRADIATED MATERIALS. I. A. Domoryad and L. P. Khiznichenko. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 284-?(1961).

The effects of 1.25-Mev gamma rays on fused quartz were studied by the method of torsional oscillations. Changes in elasticity of 0.16% are reported. (R.E.U.)

37769 (AEC-tr-6398(p.495-504)) HETEROGENEOUS SENSITIZATION OF RADIOCHEMICAL PROCESSES ON A SEMICONDUCTOR-SOLUTION BOUNDARY. D. M. Shub, G. S. Tyurikov, and V. I. Veselovskiĭ. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 370-?(1961).

The excitation of heterogeneous sensitization processes, which occurs as a result of the transformation of radiant energy to the energy of electronic excitation of the sensitizer, was studied for the boundary of separation of a solid and the reaction medium. Oxide semiconductors (sensitizers) of the types ZnO, Fe_2O_3, Cu_2O, etc., were irradiated with gamma rays from ^{60}Co in aqueous solutions. Radiochemical product yield increases were studied. (R.E.U.)

37770 (AEC-tr-6398(p.521-8)) A STUDY OF THE INFLUENCE OF IONIZING RADIATION ON THE MOISTURE PERMEABILITY OF POLYETHYLENE. D. S. Parfenova, Z. F. Sokolova, É. É. Finkel, and K. V. Chmutov. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 389-?(1961).

Variations in permeability of polyethylene to water were studied after gamma irradiation at 46 to 299 Mrad. The instrumentation used for detection of the tritium-labeled water is described. (R.E.U.)

37771 (AEC-tr-6398(p.538-46)) EFFECTS OF IONIZING RADIATIONS ON THE PROPERTIES OF WOOD AND

ITS COMPONENTS. A. S. Freĭdin, Yu. M. Malinskiĭ, and V. L. Karpov. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 401-? (1961).

The effects of gamma radiation on wood properties and composition were studied for dose rates of 0.6 to 0.9 Mrad/hr. (R.E.U.)

37772 DOUBLE BRAGG SCATTERING OF X-RAYS IN IRRADIATED BERYLLIUM OXIDE. R. M. Mayer and T. M. Sabine (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Acta Cryst., 17: 1073-4(Aug. 20, 1964).

Double Bragg scattering of x rays was investigated in BeO which had been irradiated to a dose of 2.5×10^{20} nvst at 75–100°C (>1 Mev). The intensity distribution of forbidden 001 reflections was examined by rotating the crystal about the respective scattering vectors of the reflecting planes. A series of peaks was observed, which repeated every 60° of azimuth and was symmetrical about the midpoint of each range. The reflections were identified by calculation of the crystal settings, which gave rise to simultaneous intersection of the Ewald sphere by two reciprocal lattice points. When one of these reflections was itself forbidden, no peak was observed. Also, the defect concentration did not destroy the perfection of the crystal sufficiently for double Bragg scattering effects to disappear. (P.C.H.)

37773 AN INDUCTIVE EFFECT IN A SURFACE BARRIER Si DIODE CAUSED BY REDUCTION OF CARRIER CONCENTRATION BY γ IRRADIATION. L. Cathey and H. R. Tilley, Sr. (E. I. du Pont de Nemours & Co., Aiken, S. C.). Appl. Phys. Letters, 5: 103-4(Sept. 1, 1964).

An inductive effect was observed during radiation damage tests on silicon alpha counters in which the junction capacity was one of the measured properties. The inductive effect was evident when the measured capacity of the diode went through zero to negative values as the diode bias was changed. The diodes were exposed to 1.9×10^7 and 2.5×10^8 R of ^{60}Co gammas. (C.E.S.)

37774 THE EFFECTS OF NEUTRON IRRADIATION ON MAGNETIC MOMENT IN Fe_3Al ALLOY. G. P. Saenko (Kurchatov Inst. of Nuclear Energy, [Academy of Sciences, USSR]). Fiz. Metal. i Metalloved., 17: 689-92(May 1964). (In Russian)

Effects of neutron irradiation on magnetic moments in saturated iron alloys with 24.8 at. % Al were investigated. Irradiation with 7×10^{19} n/cm^2 at ~80°C alters the magnetic moment in Fe_3Al. In annealed and tempered alloys irradiation disturbed the ordered distribution of atoms, and in disordered states it stimulated processes leading to a more equilibrium state. (R.V.J.)

37775 EXO-ELECTRON EMISSION AND ANNEALING OF RECOIL DAMAGE. Amar Nath (Atomic Energy Establishment, Trombay, India). Indian J. Chem., 2: 332 (Aug. 1964).

The observation that crushing, irradiation with ionizing radiation, incorporation of a multicharged cationic impurity, and compression sensitize the neutron-irradiated material to subsequent thermal annealing, was explained on the basis of the model given previously. Vacancies, thallium impurity, etc., act as electron trapping centers from where the electrons are released during thermal treatment. Irradiation with ionizing radiation or emission of exo-electrons during crushing and compression, refill the electrons in the traps. (auth)

37776 IMPURITY NUCLEATION OF IRRADIATION DAMAGE IN GRAPHITE. P. A. Thrower (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 12: 56-60(May-June 1964). (AERE-R-4463)

In highly purified graphite single crystals irradiation damage is known to nucleate homogeneously. In crystals exposed to boron contamination a higher density of nucleated defect sites was observed. From a detailed study at different irradiation temperatures, estimates may be obtained of the density and depth of the impurity traps involved. A similar increase in site density was obtained by subjecting crystals to a short pre-irradiation at a lower temperature and a comparison was made between the types of defect produced under these two conditions. (auth)

37777 RADIATION EFFECTS IN IONIC CRYSTALS. K. Shvarts. Latvijas PSR Zinatnu Akad. Vestis, No. 4, 30-7(1964). (In Russian)

Results are reported from studies on ionic crystals. Data are included on the transfer of energy from the basic substance to an activation, transfer of electric charge, accumulation of energy, production of radiation damage, and the microstructure of impurity centers and of irradiated crystals. (IIC-MG)

37778 ELECTRON MICROSCOPE OBSERVATION OF NUCLEAR REACTIONS. Lewis T. Chadderton and Ian McC. Torrens (Cambridge Univ., Eng.). Nature, 203: 387-9(July 25, 1964).

In an attempt to observe directly the damage caused by lightly ionizing particles, thin crystals of MoO_3 were irradiated with ^{3}He ions of energy 29 Mev. Observation of crystals bombarded by 10^{15}–10^{16} ions/cm^2 revealed a number of particle tracks, which were occasionally darker than the surrounding crystal due to the operation of diffraction contrast but were more often light tracks due to the removal of material of the crystal. The track thickness was generally considerably less than that of fission-fragment tracks, varying from ~25 to ~100 Å. The results imply that the tracks observed in the crystals are formed as a consequence of collisions between ^{3}He ions and nuclei of the crystal or grid atoms, in which penetration of the nuclear potential barrier occurs, leading to transmutations and a high-energy transfer to the product nuclei. (P.C.H.)

37779 DIRECT INTERACTIONS BETWEEN DISLOCATIONS AND POINT DEFECTS IN X-IRRADIATED NaCl. R. W. Davidge (Laboratorium voor Kristallografie en Studie van Vaste Stoffen, Ghent). J. Phys. Chem. Solids, 25: 907-9(Aug. 1964).

An investigation was made on the effects of the formation of point defects during x irradiation on the electrical charge on edge dislocations in NaCl. It is shown that dislocations, originally negatively charged, can under certain conditions acquire a positive non-equilibrium charge. Dislocations were introduced after irradiation and optical bleaching and the sign of the charge of edge dislocations vibrating at 200 c/s was then determined. All operations were performed at room temperature. The absorption spectrum for a crystal containing 2×10^{17} F-centers per cm^3 showed also a small M-band (absorption coefficient, $\alpha = 1.0$ cm^{-1}) and general uv absorption rising to a maximum at 200 mμ ($\alpha = 0.7$ cm^{-1}) but with no resolvable peaks. The F-band was reduced to zero by bleaching. The M-band intensity increased after a short bleaching time (to a maximum of $\alpha = 1.7$ cm^{-1}) and then fell to zero. The absorption at 200 mμ increased during optical bleaching (to $\alpha = 1.8$ cm^{-1}) and was reduced by 50% after a one-hour anneal at 200°C and completely after a further hour at 250°C. (P.C.H.)

37780 NUCLEAR POLARIZATION BY HOT ELECTRONS. L. L. Buishvili (Inst. of Cybernetics, Academy of Sciences, Tbilisi, Georgian SSR). Soviet Phys.-Solid State

(English Transl.), 6: 85-8(July 1964). (Translated from Fiz. Tverd. Tela, 6: 108-12(Jan. 1964).

A study was made of a semiconductor with hot electrons, paramagnetic impurities, and nuclear spins. The equation for the Zeeman temperature, in simple zone, for free and impurity electrons was derived and investigated. (auth)

37781 ORIENTATION DEPENDENCE OF THE FORMATION OF RADIATION DEFECTS IN n-TYPE SILICON. I. V. Kryukova and V. S. Vavilov (Moscow State Univ.). Soviet Phys.-Solid State (English Transl.), 6: 266-7(July 1964). (Translated from Fiz. Tverd. Tela, 6: 329-31(Jan. 1964).

Single crystals of n-type silicon were investigated to determine the orientation dependence of the rate of formation of defects. Radioinduced defects were recorded by investigating the change in the minority carrier life time τ during irradiation. Defects were produced in the active layer by an oriented beam of electrons, which was the main condition for the observation of the orientation dependence; n-type silicon doped with Li was also investigated. It was found that bombardment along the ⟨111⟩ axis produced greater changes in the crystal than that along the ⟨110⟩ and ⟨100⟩ axes. The observed orientation dependence is related to the presence of natural interstitial positions in the loose diamond-type lattice. However, the possibility of the transitions of atoms from their lattice sites to the positions with indexes (002), (020), or (200) cannot be rejected when fast-electron scattering is accompanied by the transfer of momentum at an angle to the direction of incidence of the electron beam ⟨111⟩. (P.C.H.)

37782 CONDUCTIVITY AND HALL CONSTANT. XXIX. EFFECTS OF NEUTRON IRRADIATION ON α-COPPER–ALUMINUM ALLOYS. Werner Koester and Rolf E. Hummel (Max-Planck-Institut für Metallforschung, Stuttgart). Z. Metallk., 55: 388-91(July 1964). (In German)

Electric resistivity, Hall constant, and thermoelectric power of a Cu based alloy with 7.5% by weight Al were investigated as a function of thermal and mechanical treatment as well as neutron irradiation. After irradiation at 70°C the resistivity of a recrystallized specimen decreases rapidly by 6.4% and is followed by a gradual increase. The Hall constant decreases by 14.2% to a constant value. Resistivity and Hall constant of a deformed sample decrease continuously during irradiation. The greatest amount of ordering was obtained by aging a cold-worked and irradiated sample. This can be explained by a surplus of vacancies, induced by healing-out of the interstitials at dislocations at room temperature. The Hall constant of a recrystallized alloy may be considered as a measure of short range order. (auth)

37783 EFFECTS OF RADIATION ON MATERIALS AND COMPONENTS. John F. Kircher and Richard E. Bowman. eds. New York, Reinhold Publishing Corp., 1964. 701p. $22.50.

Nine chapters on radiation effects on organic materials, ceramics and metals, and semiconductors and electronic components are included. Each chapter is abstracted separately. (P.C.H.)

For abstracts of individual chapters see: 37245, 37246, 37247, 37550, 37784, 37785, 37786, 37787, and 37788.

37784 BASIC CONCEPTS OF RADIATION EFFECTS. John F. Kircher (Battelle Memorial Inst., Columbus, Ohio). p.11-48 of "Effects of Radiation on Materials and Components." New York, Reinhold Publishing Corp., 1964.

Two fundamental problems are discussed: the nature of the damaging radiations and their interaction with matter; and the mechanism by which the primary interaction of radiation and matter leads to a change in the physical, mechanical, and/or chemical properties of matter. Special attention is given to neutrons and gamma rays. (P.C.H.)

37785 EFFECTS OF RADIATION ON CERAMIC MATERIALS. R. A. Wullaert, R. J. Burian, J. B. Melehan, M. Kangilaski, and J. E. Gates. p.277-402 of "Effects of Radiation on Materials and Components." New York, Reinhold Publishing Corp., 1964.

The typical effects of radiation on ceramics are listed and the effects of radiation on the important engineering properties of ceramics are surveyed. The ceramics discussed include: oxides, carbon, carbides, inorganic cements and adhesives, glass, silicates and aluminates, titanates and niobates, ferrites, and mica and asbestos. 228 references are included. (P.C.H.)

37786 STRUCTURAL METALS AND ALLOYS. Frederic R. Shober. p.403-72 of "Effects of Radiation on Materials and Components." New York, Reinhold Publishing Corp., 1964.

A review is presented on radiation effects on structural and physical properties of ferrous metals and alloys, nonferrous metals and alloys. The data indicate that there are many pronounced changes in the engineering properties of structural materials after exposure to neutron fluxes. The changes in properties are related to the structural conditions of the metals. Variables that appear to influence the degree of change in structural metals and alloys, as noted by preirradiation measurements, include such properties as crystal structure, grain size, chemical composition, melting point, and thermal and fabrication history. Other factors include neutron flux density, total neutron exposure, temperature of irradiation, stress conditions, and irradiation sample environment. 89 references are included. (P.C.H.)

37787 SEMICONDUCTOR DEVICES. F. J. Reid. p.473-536 of "Effects of Radiation on Materials and Components." New York, Reinhold Publishing Corp., 1964.

A review is presented on the effects of radiation on semiconductor devices, including transistors, diodes and rectifiers, diodes, and solar cells. Radiation damage to physical properties, transient effects, and mechanisms of radiation effects are discussed. 87 references are included. (P.C.H.)

37788 ELECTRONIC COMPONENTS. D. J. Hamman, W. E. Chapin, C. L. Hanks, and E. N. Wyler. p.537-667 of "Effects of Radiation on Materials and Components." New York, Reinhold Publishing Corp., 1964.

Radiation-effects information is summarized for the following electronic components: electron tubes, resistive components, capacitors, insulation and insulators, transformers, foil-clad laminates, piezoelectric crystals, electric meters, electrical connectors, relays, and switches. 109 references are included. (P.C.H.)

METEOROLOGY

37789 (A/CONF.28/P/383) QUANTATIVE INVESTIGATIONS OF ATMOSPHERIC MOTIONS BY MEANS OF RADIOACTIVE TRACERS. I. L. Karol, S. G. Malakhov, V. D. Vilenskii, G. V. Dmitrieva, Y. V. Krasnopievtzev, L. V. Kirichenko, and T. I. Ssissiguina (U.S.S.R.). May 1964. 18p.

The study of distribution of radioactive substances in the lower air layers of the earth atmosphere conducted in various geographic points has given important information on some large-scale processes taking place in the atmosphere. Materials of 11 ocean expeditions collected between 1958 and 1963 and continental data made it possible to study general meridional circulation of atmosphere, intercommunication between concentration of radioactive substances and atmospheric pressure, air masses exchange between hemispheres, certain characteristics of the air masses exchange between troposphere and stratosphere, influence of ocean and land surfaces upon air masses exchanges between the troposphere and stratosphere, and the role of meteorological fronts, as the demarcation line of various air masses. (auth)

37790 (A/CONF.28/P/383a) INVESTIGATION OF AIR MASSES LABELLED BY ARTIFICIAL AND NATURAL NUCLIDES TO SOLVE SOME EARTH ATMOSPHERE DYNAMIC PROBLEMS (BASED ON SEA EXPEDITION MATERIALS). (U.S.S.R.). May 1964. 19p.

Studies were made of nuclear explosion products and ^{7}Be in near-ground air and at various altitudes above the oceans. The meridional distributions of ^{7}Be, ^{181}W, ^{144}Ce, and total beta activity are given. The movement of air masses in the low stratosphere and troposphere is discussed, and a scheme of meridional circulation is proposed. (D.L.C.)

37791 (A/CONF.28/P/714) RECENT DEVELOPMENTS IN THE APPLICATION OF METEOROLOGY TO REACTOR SAFETY. D. H. Pack, J. K. Angell, I. Van der Hoven, and D. H. Slade (Weather Bureau, Washington, D. C.). May 1964. 20p.

Meteorological approaches to reactor siting are described. Nation-wide analyses of vertical lapse rate and methods for determining the persistence of wind regimes are considered. The use of conventional meteorological observations to infer diffusion regimes is described and illustrated for several locations. Use of wind fluctuations to obtain diffusion coefficients was improved and empirical techniques developed that permit use of conventional wind systems. Smoke photography techniques that permit quantitative analysis are described, together with illustrations of the field use of particulate tracer techniques in special problems. One of the newest meteorological techniques for application to nuclear sites is the use of balloon borne radar beacons to obtain air trajectories and diffusion data over ranges up to 100 miles. This technique, and its potential, is described. (auth)

37792 (NEL-1207) PROJECT FISHBOWL EFFECTS ON OMEGA VLF TRANSMISSIONS. PHASE AND AMPLITUDE EFFECTS DURING EVENTS STARFISH, BLUEGILL TRIPLE PRIME, AND KINGFISH. C. J. Casselman, R. L. Denton, and J. J. Wilson (Navy Electronics Lab., San Diego, Calif.). Dec. 20, 1963. 74p. (AD-435972)

The study reported was undertaken to measure the effects on the vlf carrier used by the Omega navigation system during Project FISHBOWL. The three events of the FISHBOWL Project under consideration were designated STARFISH (9 July 1962), BLUEGILL Triple Prime (26 October), and KINGFISH (1 November 1962). The sections covering the various types of measurement include recordings from all three events and describe the instrumentation and procedures employed. In the descriptions of the tests no extensive analysis of the results is made. However, any faults of system operation, or known irregularities in the recordings, are mentioned or illustrated. (auth)

37793 (NASA-TT-F-141) PROCEEDINGS OF THE CENTRAL AEROLOGICAL OBSERVATORY, NO. 42. G. A. Kokin and N. S. Livshits, eds. Translation of "Trudy Tsentral'noy Aerologicheskoy Observatorii," No. 42, Gidrometeorologicheskoye Izdatel'stvo (Otdeleniye), Moscow, 1962. 200p.

Certain aspects of mass spectrometric analysis are considered in the 14 papers presented. Separate abstracts were prepared for 11 of the papers; the remaining are on characteristics of tungsten filaments as thermometric substances, a transistor switching circuit, and a magnetic recording system for meteorological parameters. (R.E.U.)

For abstracts of individual papers see: 37480, 37481, 37482, 37483, 37484, 37485, 37486, 37487, 37488, 37794, and 37795.

37794 (NASA-TT-F-141(p.1-21)) SOME DATA ON THE COMPOSITION OF THE UPPER LAYERS OF THE ATMOSPHERE. A. V. Fedynskii. (A translation).

A review is given of modern data on the neutral and ionic composition of the upper layers of the atmosphere based on the results of rocket soundings. (auth)

37795 (NASA-TT-F-141(p.143-51)) THE POSSIBILITY OF MEASURING THE MOBILITIES AND CONCENTRATION OF CHARGED PARTICLES IN THE ATMOSPHERE BY THE METHOD OF ELECTRICAL SHUTTERS. Yu. A. Bragin. (A translation).

A method and circuit for measuring the mobilities and concentrations of positive ions is described. In the form described here, the measurement circuit and method are suitable over a pressure range from approximately 50 to 10^{-2} mm Hg. The results of laboratory tests of the instrument are presented. (auth)

PHYSICS

General

37796 (EUR-1848.e) COMPUTATION OF THE FLOW BEHIND A CONVERGING DETONATION FRONT IN CYLINDRICAL OR SPHERICAL GEOMETRY. L. Guerri and A. Taroni (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 29p.

A finite-difference scheme is described for the computation of the gas flow behind a converging cylindrical or spherical detonation front together with the front trajectory. The scheme may also be applied to the plane case, which affords the possibility of a check with the known solution given by a simple rarefaction wave centered in the origin of the detonation. (auth)

37797 (IITRI-1184-14) MAGNETIC PROPERTIES OF INSULATORS. Quarterly Report No. 14, May 16–August 15, 1964. J. J. Markham (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Sept. 5, 1964. Contract AT(11-1)-587. 37p.

A spin-hamiltonian containing the interaction of a one-electron defect with the surrounding ions is derived. It is shown, by means of the gauge invariance of perturbation theory, that for a many-center imperfection in a magnetic field, one may choose the "natural" gauge for each force center without affecting the gauge invariance of the spin-hamiltonian. The spin-hamiltonian is a type of perturbation expansion, and the above result is found to be a consequence of the gauge properties of perturbation theory when spin-orbit coupling is included. The spin-hamiltonian is applied to some qualitative calculations of the g-shift of the V_K-center for the case of non-orthogonal atomic orbitals. (auth)

37798 (NASA-TN-D-2460) LOW-COVERAGE HEATS OF ADSORPTION. III. ALKALI METAL IONS ON TUNGSTEN; ATOM-METAL INTERACTION THEORY. Harold E. Neustadter and Keung P. Luke (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Aug. 1964. 7p.

The heat of adsorption of an ion on a metal (in the limit of zero coverage) is expressed as the superposition of a van der Waals type interaction and an image charge type interaction. The reported experimental values of the heat of adsorption of sodium, rubidium, and cesium ions on a tungsten substrate are then compared with results of a theoretical evaluation based on the above model. (auth)

37799 (UCRL-7940) HISTORY OF THE LENZ-ISING MODEL. Stephen G. Brush (California. Univ., Livermore. Lawrence Radiation Lab.). June 19, 1964. Contract W-7405-eng-48. 61p.

The general theory of the Lenz-Ising model (Ising model) of ferromagnetic and other physical systems is discussed. A bibliography of 409 references is given. (R.E.U.)

37800 ADIABATIC INVARIANCE. III. THE EQUATION $\ddot{x} = -V_x(x,\omega)$. J. E. Littlewood (Trinity Coll., Cambridge, Eng.). Ann. Phys. (N. Y.), 29: 1-12(Aug. 1964).

In the equation $\omega = \omega(t)$ is a slowly varying function of t for $-\infty < t < \infty$. If ω is replaced by a constant equal to the momentary value ω_τ at $t = \tau$, the modified equation has an integral $\frac{1}{2}\dot{x}^2 + V(x,\omega_\tau) = C$, and for appropriate V, and $C > 0$, there is a momentary periodic motion between $x = X'$ and X, of period $p = \sqrt{2}\int_{X'}^{X}\{V(X,\omega_\tau) - V(\xi,\omega_\tau)\}^{-\frac{1}{2}}d\xi$. Associated with this there is an Adiabatic Invariant $J(\tau) = \oint \dot{x}\,dx = 2\sqrt{2}\int_{X'}^{X}\{V(X,\omega_\tau) - V(\xi,\omega_\tau)\}^{-\frac{1}{2}}d\xi$. It is shown that $J(\tau)$ is constant in $-\infty < t < \infty$ to error $O(\epsilon^{\frac{1}{2}})$, where ϵ is a measure of the slowness of variation of ω. (auth)

37801 ADIABATIC INVARIANCE. IV. NOTE ON A NEW METHOD FOR LORENTZ'S PENDULUM PROBLEM. J. E. Littlewood (Trinity Coll., Cambridge, Eng.). Ann. Phys. (N. Y.), 29: 13-18(Aug. 1964).

An alternative method for the problem, which was previously discussed, is outlined. The new method seems likely to be better suited than the old for a discussion of the problem of multiple periods, and it has some formal interest. (auth)

37802 THEORY OF PROPAGATION OF MAGNETOHYDRODYNAMIC WAVES IN CYLINDRICAL TUBES. D. Ullmann (Friedrich-Schiller-Universität, Jena, Ger.). Ann. Physik (7), 13: 179-88(June 1964). (In German)

Expanding magnetohydrodynamic torsion waves in a cylindrical tube, in the presence of a longitudinal magnetic field, were investigated. The basic equations were derived and applied to conditions of wave spreading without turbulence, to magnetohydrodynamic torsion waves, to magnetoacoustic waves, and to conditions of wave spreading with turbulence. In a flowing medium there appears to be a possibility of undamping for the magnetoacoustic wave. (R.E.U.)

37803 EXCESS ENERGY ELECTRONS. E. H. Hirsch (Weapons Research Establishment, Salisbury, South Australia). Brit. J. Appl. Phys., 15: 909-16(Aug. 1964).

If electrons from an auxiliary source are injected into a Penning-type electrode structure, some of the electrons gain high energy, enabling them to reach electrodes strongly negative with respect to the cathode. The effect occurs if a sufficiently high current is injected at or beyond magnetron cut-off. The excess energy distribution is non-Maxwellian, but a probe interaction can simulate a Maxwell distribution. Comparison with excess energy effects in glow discharges suggests a similar probe interaction as an explanation of the Langmuir paradox. (auth)

37804 ELECTRON-ION RECOMBINATION COEFFICIENTS IN AMMONIA. G. R. Court and J. Sayers (Univ. of Birmingham, Eng.). Brit. J. Appl. Phys., 15: 923-7 (Aug. 1964).

A method is described for measuring electron-ion recombination coefficients in afterglows, using a Langmuir probe to measure electron temperatures and densities and a mass spectrometer to identify the ion species present. In order to obtain reliable probe measurements it was necessary to have an electron source in the afterglow. This also enabled the afterglow electron temperature to be varied from 1000 to 2600°K. The electron-ion recombination coefficient for NH_3^+ was measured as a function of electron temperature T over this range and was found to be proportional to $T^{-2.2\pm0.2}$. A recombination coefficient of $9.4 \pm 0.5 \times 10^{-7}$ cm^3 sec^{-1} was obtained at an electron temperature of 2150 ± 50°K. The measurements were made in gas mixtures of helium with approximately 1% of ammonia. It was concluded that there was no variation of the recombination coefficient with either total gas pressure or ammonia pressure. (auth)

37805 THE TEMPERATURE DISTRIBUTIONS IN THIN FOIL AND SEMI-INFINITE TARGETS BOMBARDED BY AN ELECTRON BEAM. L. G. Pittaway (Mullard Re-

search Labs., Redhill, Surrey, Eng.). Brit. J. Appl. Phys., 15: 967-82(Aug. 1964).

The equations describing the temperature distributions produced in a target by a heat source whose radial intensity variation obeys the Gaussian distribution law are developed from the general heat flow equation. Thin foil and semi-infinite targets are considered for both stationary and moving heat sources, and the energy of the source is assumed to be absorbed entirely in the surface plane of the target. No account is taken of any change of state of the target material. The equations are solved in a general manner; and graphs are given of the results, which are applicable to any combination of target material and source parameters. (auth)

37806 MORSE POTENTIAL PARAMETERS FOR HYDROGEN. O. P. Bahethi and S. C. Saxena (Univ. of Rajasthan, Jaipur, India). Indian J. Pure Appl. Phys., 2: 267-9(Aug. 1964).

The available second virial, viscosity, and diffusion data of hydrogen were interpreted in terms of the three parameter Morse potential. It is found that different choices of parameters are essential to represent the equilibrium and non-equilibrium properties. (auth)

37807 ON THE INTERACTION BETWEEN LATTICE VIBRATIONS AND ELECTROMAGNETIC FIELDS IN CRYSTALS. V. Gallina and M. Omini (FIAT Research Labs., Turin). Nuovo Cimento (10), 33: 1031-55(Aug. 16, 1964).

By the use of second quantization theory, the interactions between the electromagnetic field and the field produced by lattice vibrations in a crystal, are studied. The emphasis is put on the harmonic lattice vibrations, i.e., phonon-photon interactions. Among these the more interesting ones result to be the Bragg scattering, the first-order Raman scattering (including thermal scattering of light), and the second-order Raman scattering. Cross sections in terms of lattice properties are given for all these effects. (auth)

37808 SIMULTANEOUS OCCURRENCE OF THE CORONA PRESSURE AND POSITIVE JOSHI EFFECT IN HYDROGEN. R. J. Galagali (Banaras Hindu Univ., India). Phys. Letters, 11: 223-4(Aug. 1, 1964).

The conditions for the occurrence of the corona pressure (Δp) phenomenon and the positive Joshi effect ($+\Delta i$) in the same potential range were investigated by observations in hydrogen under a low-frequency ozonizer discharge. Δp in darkness and under light and $\pm\Delta i$ were measured at pressures from 1 to 500 mm Hg. Simultaneous occurrence of $+\Delta i$ and Δp was observed at 121, 145, 171, 203, and 306 mm Hg over a limited potential range. (D.C.W.)

37809 REMARKS ON MATSUDA'S THEOREM. Junichi Hori (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto), 31: 940-2(May 1964).

The disappearance of the density of the frequency spectrum of an isotopically disordered diatomic lattice at special frequencies is shown by a simple argument, and the argument is shown to be valid for an isotopically disordered polyatomic lattice. (D.C.W.)

37810 ON THE CALCULATION OF THE VIRIAL COEFFICIENTS OF HYDROGEN GAS FROM EXPERIMENTAL DATA. Zhu-xi Wang and Li-yuan Chang (Peking Univ.). Sci. Sinica (Peking), 13: 1211-20(Aug. 1964).

The methods of calculating the virial coefficients in the equation of state of gases were investigated, and four rules for determining the number of terms in the equation of state were proposed. These rules are: variation of Σv^2 ($v = (pV)_{cal} - (pV)_{exp}$) is to be used; each succeeding term of the polynomial should be less in numerical value than its preceding term; the last term of the polynomial should be of the same order of magnitude as the experimental error; and the residuals v should have nearly equal numbers of positive and negative values. The use of the condition $A_0 + B_0 + C_0 + \cdots = 1$, but not the condition $A = RT$ is advised. It was also investigated whether the expansion is better in increasing powers of pressure or of density, the omission of odd power terms, the number of significant figures in the numerical values of the virial coefficients, and the correction of some experimental data. The virial coefficients of hydrogen gas were calculated from two different sets of experimental data, and results differing from those of the original authors were obtained. The virial coefficients thus calculated from the two different sources agree within twice the standard error, and differ less than those of the original authors. (auth)

37811 ON THE MOTION OF CHARGED PARTICLES IN A MAGNETIC FIELD. B. I. Morgunov. Vestn. Mosk. Univ., Ser. III, Fiz. Astron., No. 2, 3-7(Mar.-Apr. 1964). (In Russian)

Drift equations were developed for an axially symmetric magnetic field. An approximate integral was obtained for an exact equation of motion, the properties of which were studied using a special numerical example. (tr-auth)

37812 KINETICS, EQUILIBRIA, AND PERFORMANCE OF HIGH-TEMPERATURE SYSTEMS. Proceedings of the 2nd Conference, April 1962, Los Angeles, California. Gilbert S. Bahn, ed. New York, Gordon and Breach Science Publishers, 1963. 403p. $19.50. (CONF-288)

The topics discussed include differences between calculated and delivered specific impulse, thermodynamic properties of light-metal compounds, metal-oxide systems, computer calculations of ideal-gas thermodynamic functions, high order corrections on thermodynamic properties of polyatomic molecules, equilibrium thermodynamic properties of multiply ionized multicomponent plasmas, the Pennington and Kobe equations, equilibrium composition and properties in gas obeying virial equation of state, chemical equilibrium in real gas system, singularities in Newton-Raphson solution of chemical equilibria, specific impulse computer program, computer program for evaluation of rocket fuels, solution method for thermo-chemical problems, a Mollier diagram for stoichiometric pentaborane and hydrazine, a kinetic model for multicomponent mixtures, equilibrium determinations in high temperature air, Bray criterion for predicting atomic recombination effects in propulsion systems, reassociation rate constants for performance analysis of jet propulsion exhaust nozzles, transport and thermodynamic properties of partially ionized gases, the chemical state of the shock layer at the stagnation region of a spherical body traveling at hypersonic speed, and a parametric method for designing rocket nozzles. Not all of the papers presented at the conference are included in the proceedings. Separate abstracts are prepared for 2 of the 21 papers included. (C.E.S.)

For abstracts of individual papers see: 38227 and 38228.

37813 THREE-DIMENSIONAL MAGNETOHYDRODYNAMIC JET-VORTEX OF A VISCOUS CONDUCTING FLUID. Hsien-Ping Pao. Thesis, Baltimore, Johns Hopkins Univ., 1963. 150p.

Various solutions are given of a three-dimensional magnetohydrodynamic jet-vortex in a viscous, incompressible, conducting fluid. A general theory is developed that

leads to a reduction of the steady-state equations of motion and the equations of magnetic induction to five ordinary, non-linear, differential equations. The asymptotic behavior is analyzed, and some particular cases are considered. Two different assumptions lead to two kinds of boundary layer approximations. An analytical solution of the first kind is obtained when the conductivity is infinite or infinitesimal. Numerical solutions of the second kind are also given. The solutions for the second kind may be considered as a generalization of Long's vortex solutions when magnetohydrodynamic interaction is present. Governing equations in spherical coordinates are also presented with consideration given to some simple cases. A source of heat is introduced at the origin as an idealized representation of a heated jet-vortex. A possible astrophysical application to the sun spot phenomenon is discussed. In the Appendix, a proof of sufficient conditions for stability of a revolving conducting fluid in a circular magnetic field is given when both viscosity and conductivity are finite. (Dissertation Abstr., 24: No. 12, Pt. I (June 1964))

37814 ADVANCES IN APPLIED MECHANICS. VOLUME 8. H. L. Dryden and Th. von Kármán, eds. New York, Academic Press, 1964. 306p. $12.00.

The eighth volume includes articles on magneto-aerodynamic flow past bodies, incompressible second-order fluids, sound generation by turbulent jets, stability of motion of solid bodies with liquid-filled cavities, and oscillations of liquid-containing bodies. A separate abstract was prepared for the first article. (D.C.W.)

For an abstract of the individual section see: 37815.

37815 MAGNETO-AERODYNAMIC FLOW PAST BODIES. W. R. Sears and E. L. Resler, Jr. (Cornell Univ., Ithaca, N. Y.). p.1-68 of "Advances in Applied Mechanics. Vol. 8." New York, Academic Press, 1964.

The steady flow of incompressible fluids with infinite electric conductivity and with increasing resistivity past solid objects in investigated, together with the effects of compressibility in inviscid, perfectly conducting flows. Finally, it is shown that even perfect conductors may exhibit appreciable Hall effect. (D.C.W.)

Accelerators

Refer also to abstract 37969.

37816 (LNF-64/16) SULLA UTILIZZAZIONE DEL LINAC PER EFFETTUARE DELLA SPERIMENTAZIONE CON PIONI. (Use of a Linac for Experiments with Pions). Note No. 240. C. Schaerf (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). May 18, 1964. 7p.

A system is proposed by which the Frascati Linac could be used for the production of a beam of low-energy pions. In order to indicate the effective counting speed that could be obtained with the system, the scattering of pions on carbon is calculated. The calculation of the number of pions photoproduced in a light target is presented. (J.S.R.)

37817 (NP-14123) ÉTUDE DES CIBLES MINCES CHARGÉES DE TRITIUM UTILISÉES DANS LES ACCELÉRATEURS PRODUISANT DES NEUTRONS RAPIDES PAR LA REACTION (D-T) (THÈSE). (Study of Thin Targets Loaded with Tritium Utilized in Accelerators Producing Fast Neutrons by the (d + T) Reaction (thesis)). Henri Rème (Toulouse. France. Université). [1962]. 50p.

The role of all the factors limiting the yield of thin tritium targets is defined, and a study on the improvement of these targets by a thermodynamic study of the tritium content is undertaken. The different devices giving a precise knowledge on the neutron flux are described. These devices allowed the systematic study of the yield of new targets, the examination of the evolution of the yield as a function of the number of incident deuterons, and the determination of the life of these targets at high fluxes. A thermodynamic study was made of the targets in a vacuum. The temperature at which the tritium leaves the target and the relative tritium loss of the targets as a function of temperature are then determined. A measurement is made of the heating of the targets in the accelerator. The failure to attain the theoretical yield and the non-conservation of the yield or origin are explained. Techniques for the utilization at high neutron flux, fabrication of more stable targets, and regeneration of used targets are given. (tr-auth)

37818 (NP-14168) ETUDE ET REALISATION D'UN DISPOSITIF DE PULSATION DE FAISCEAU PAR REGROUPEMENT MAGNETIQUE DANS LE DOMAINE DE LA NANOSECONDE (theses). (Study and Development of a Beam Pulsation Device With Magnetic Bunching in the Nanosecond Region (thesis)). Gerard Jourdet (Lyon. Université). July 9, 1963. 106p.

The characteristic parameters of a beam pulsation system and their effect on the resolution of a beam pulsation device with magnetic bunching were studied. The general principles of operation are defined and expressed mathematically. The construction of the bunching magnet is described. The auxiliary apparatus completing the bunching system was studied. The different methods possible for the measurement of the pulsed beam are described. Experimental results on the bunching, obtained from the reaction $^3H(p,n)^3He$ with 2-Mev protons, are reported. (J.S.R.)

37819 (UCRL-11438) A POLARIZED PROTON TARGET. Owen Chamberlain, Claude Schultz, and Gilbert Shapiro (California. Univ., Berkeley. Lawrence Radiation Lab.). July 3, 1964. Contract W-7405-eng-48. 21p. (CONF-550-10)

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

The production of polarized proton targets by dynamic nuclear orientation is discussed, and some experimental uses are reviewed. Targets of hydrous lanthanum magnesium double nitrate were tested experimentally. (R.E.U.)

37820 (UCRL-11527) A VARIABLE MOMENTUM SEPARATED K^+ BEAM AT THE BEVATRON. Robert B. Bell, Roger W. Bland (California. Univ., Berkeley. Lawrence Radiation Lab.); C. Thornton Murphy, et al. (Wisconsin. Univ., Madison). July 7, 1964. Contract W-7405-eng-48. 9p. (CONF-550-15)

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

A two-stage, separated K^+ beam layout was built and successfully operated at the Bevatron using a target in the new external proton beam as the source of secondary particles. Some features of the beam include relatively large solid angle, short length, and wide operating range of beam momenta (approximately 800 to 1600 Mev/c). Details of the design and operation of the beam, as well as measured particle flux values appropriate to zero-degree production, are presented. (auth)

37821 SIMPLE TECHNIQUE FOR ACHIEVING ULTRA-HIGH VACUUM IN A PROTON ACCELERATOR. T. W. Snouse (Ames Research Center, Moffett Field, Calif.). Appl. Phys. Letters, 5: 122-3(Sept. 15, 1964).

The transmission of proton beams through thin Al_2O_3

films was investigated, together with the limitations on beam current density and film mounting. The results show that thin (200 to 1000 Å) Al_2O_3 films can be used as ion beam windows between the normal accelerator vacuum ($\sim 2 \times 10^{-6}$ torr) and a clean target-area vacuum in the 2×10^{-10} torr range. (D.C.W.)

37822 THE 1200 Mev SYNCHROTRON AT THE UNIVERSITY OF LUND. Olle Wernholm. Arkiv Fysik, 26: 527-73(1964).

The electron synchrotron and its operation are described, with emphasis on the development of the magnet system and the pre-accelerator (6.4 Mev, 20 mamp/pulse). The pertinent theory is also outlined. The synchrotron beam intensity is about 10^9 electrons/pulse. Alternating-gradient focusing is used. (D.C.W.)

37823 PROJECT FOR STORAGE RINGS FOR THE CERN PROTON-SYNCHROTRON. Fritz-Alfred Ferger (European Organization for Nuclear Research, Geneva). Ind. At., 8: Nos. 5-6, 65-70(1964). (In French)

The energy available in the collision of a moving particle with a stationary particle and a particle moving in the opposite direction is calculated, using 25-Bev protons as an example. The model storage ring constructed and operated at CERN is briefly described, and the two concentric storage rings proposed for the CERN synchrotron are briefly discussed. (D.C.W.)

37824 DESCRIPTION OF A DEVICE USED TO MEASURE ION BEAM EMITTANCE. P. H. Rose, R. P. Bastide, N. B. Brooks, J. Airey, and A. B. Wittkower (High Voltage Engineering Corp., Burlington, Mass.). Rev. Sci. Instr., 35: 1283-5(Oct. 1964).

The beam emittance was measured by an instrument consisting of a slowly moving sampling aperture located in front of a rapidly moving pickup wire. The position of the aperture and the difference between the position of the wire and that of the aperture were impressed upon the x and y plates, respectively, of a storage oscilloscope. Each time the pickup wire passed through the beam sampled by the aperture, a signal was produced. The width of this signal, which depended upon the convergence or divergence of the beam sampled, was used to pulse-brighten the oscilloscope. (In this way an area was plotted on the oscilloscope which was directly proportional to the beam emittance.) (auth)

37825 BUNCHING OF A BEAM OF 20-kev NEUTRAL HYDROGEN ATOMS. P. H. Rose, A. B. Wittkower, N. B. Brooks, R. P. Bastide, and M. Legros (High Voltage Engineering Corp., Burlington, Mass.). Rev. Sci. Instr., 35: 1286-9(Oct. 1964).

A beam of 20-kev neutral hydrogen atoms was formed by electron attachment in a hydrogen gas canal. Prior to neutralization, the protons were velocity modulated by applying an accelerating voltage to the neutralizing canal, thereby requiring only a single gap to produce bunching. The flight time of the neutral atoms, between the buncher and a target, was over 2 μsec. A minimum width of 3.7 nsec (full-width at half-height) was observed on a sampling oscilloscope and a bunching factor (peak intensity in the bunch over d-c intensity) of 37 was obtained. The minimum bunch width was related to the time spreads introduced by the energy spread of the protons from the ion source and by energy straggling in the charge-changing process. (auth)

37826 ABSOLUTE VELOCITY GAUGE FOR NUCLEAR PARTICLE BEAMS. J. D. Seagrave, J. E. Brolley, Jr., and J. G. Beery (Los Alamos Scientific Lab., N. Mex.). Rev. Sci. Instr., 35: 1290-6(Oct. 1964). (LA-DC-6011)

An instrument for determining the energies of accelerator particle beams in the 0-9 Mev range was built in the form of a coaxial cylindrical cavity. It was used to establish data points in the vicinity of the Coulomb-nuclear interference minimum in p-p scattering at 382.43 kev, with an accuracy of better than one part in 10^4 in energy. This is an order-of-magnitude higher precision than was achieved previously with this technique. The collimated particle beam passes through 0.46-mm gaps separated by the 125-cm length of a hollow inner cylinder made of Invar. The beam is intensity modulated at 72 Mc, and the cavity is tuned to the modulation frequency. As the beam energy is adjusted until the particle transit time is an odd half-multiple of the cavity period, and the shunt capacitors at opposite ends are adjusted for equal and opposite electromagnetic signals across the two gaps, a sharp null occurs in the signal picked up by an antenna in the cavity. The Q was 4000. The $^{19}F(p,\alpha\gamma)^{16}O$ resonance was relocated at 340.45 ± 0.04 kev, with an order-of-magnitude increase in precision. (auth)

37827 SEPARATION METHODS FOR HIGH-ENERGY PARTICLES. V. A. Vagin, V. I. Kotov, and I. I. Semenyushkin. Usp. Fiz. Nauk, 82: 707-48(Apr. 1964). (In Russian)

Methods for separating high-energy particles and eliminating the meson (π) background in high-energy accelerators are surveyed, including absorption, electrostatic deflection, and electrodynamic deflection. Specific separators are analyzed and described. It is concluded that suitable electrodynamic separators can be developed for accelerators with energies of 200 to 1000 Bev. (D.C.W.)

37828 POSITRON-PROTON SCATTERING FACILITY WITH A SYNCHROTRON. B. Borgia, J. W. DeWire, M. Feldman, and R. R. Wilson (Cornell Univ., Ithaca, N. Y.). p.354-6 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

The magnetic transport system constructed for obtaining a focused beam of electrons or positrons from the photon beam of the Cornell synchrotron is briefly described, together with an experiment for comparing electron and positron scattering by protons. (D.C.W.)

37829 A LIQUID-HYDROGEN TARGET FOR INTERNAL-BEAM ELECTRON SCATTERING. L. Hand, J. Rees, W. Shlaer, J. K. Walker, and Richard Wilson (Harvard Univ., [Boston]). p.364-6 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

A helium-cooled target consisting of a thin-walled target cup (usually 0.5-mil Mylar) is described. The target is located inside the vacuum chamber of the Cambridge Electron Accelerator and intercepts the circulating beam. (D.C.W.)

37830 ION ACCELERATORS. Siegfried Klein and Jacques Pottier (to Commissariat à l'Énergie Atomique). U. S. Patent 3,143,680. Aug. 4, 1964. Priority date Nov. 25, 1958, France.

A linear accelerator of the electrostatic type is designed for accelerating ion bunches. The accelerator has a series of electrodes connected through high resistors to a high voltage source, forming capacitor-like structures. When the ions strike one electrode, it is completely discharged, and a potential is set up between this electrode and the next electrode for further acceleration of the ions. (D.L.C.)

Astrophysics and Cosmology

37831 MASS LOSSES THROUGH EVAPORATION FROM A COMPLETELY IONIZED ATMOSPHERE WITH APPLI-

CATIONS TO THE SOLAR CORONA. Eberhart Jensin. Astrophys. Norveg., 8: 99-126(Apr. 1963).

Evaporative losses from an ionized hydrogen atmosphere with spherical symmetry and no magnetic fields are investigated. The approach is based on an expression for the mean free path in a medium of variable density in the case of a Coulomb collision cross section. An equation for the opening angle in the cone of escape as a function of position and velocity for a density distribution of the form r^{-n} is obtained. The evaporation rate is calculated using a method originally due to Lennard-Jones. The velocity spectrum is also determined. Numerical results are given for n = 6 and for the two temperatures, $T = 10^6$ and 1.5×10^6°K. For the first temperature the escape rate is equal to 7.0×10^{34} proton/s. At 1 A. U. this gives, with the gravitational retardation taken into account, a density of 1.2 cm^{-3} and an average velocity of 200 km/s. For the second temperature the corresponding numbers are 1.9×10^{35} protons/s, 2.7 cm^{-3}, and 290 km/s. (auth)

37832 ON THE VELOCITY FIELD IN SUNSPOTS. Per Maltby. Astrophys. Norveg., 8: 205-69(Apr. 1964).

From the study of weak Fraunhofer lines the velocity fields in isolated spots and sunspot groups were derived. For the isolated spots the radial velocity component directed horizontally out of the spot is found to be the largest in most cases, but appreciable tangential velocities are present. An upper limit equal to 0.15 km/sec is found for the vertical velocity component. Sunspot groups show a higher frequency of tangential velocities as well as a faster change in the velocity field with time than is the case for isolated spots. An abrupt change in velocity at the outer penumbral rim is detected. The observed line profiles when Evershed velocities are present were discussed. A comparison between observed and calculated line profiles shows that the velocity changes much more quickly with optical depth than previously assumed. A discussion of the continuity of the motion shows that the vertical velocity component may be small since the density increases rapidly with depth as compared with the increase in horizontal velocity with increasing distance from the spot center. (auth)

37833 MAGNETIC FIELDS OF COLLAPSING MASSES AND THE NATURE OF SUPERSTARS. V. L. Ginzburg (Lebedev Inst. of Physics, Leningrad). Dokl. Akad. Nauk SSSR, 156: 43-6(May-June, 1964). (In Russian)

The discovery of extragalactic superstars emphasized the importance of the gravitational collapse of large gas masses. An attempt is made to analyze the available astrophysical data on the collapse of very large masses, or protostars. Previous discussions of this field made use of concepts which lie outside of the current physical knowledge, such as C fields possessing a negative energy density, or it was assumed that the protostar possesses a gravitational field. This latter case requires the determination of the gravitational radius R_g. In order to clarify this problem, the effect of the magnetic field of the collapsing protostar was examined, considering specifically the isotopic compression of a conducting protostar with an initial field which continues to increase. The change of the magnetic field during the relativistic phase of the collapse was determined. A factor, $(1-R_g/R)^{-1/4}$ (where R = the radius of the protostar) must be taken into account in the calculations; therefore, if the magnetic moment does not tend toward zero as the surface of the collapsing protostar approaches a singular sphere, the effect of the magnetic energy increases and becomes a factor in the calculation. The existence of giant magnetic spheres around the large collapsing protostars would change the appearance of such stars to the external observer. Rotation of the plane of polarization of radio waves should be very noticeable even at large distances. The relativistic and nonrelativistic particles in the radiation belts may be responsible for the electromagnetic and x radiation. (TTT)

37834 NEUTRINO LUMINOSITY OF A STAR UNDER GRAVITATIONAL COLLAPSE IN GENERAL RELATIVITY. Ya. B. Zel'dovich and M. A. Podurets. Dokl. Akad. Nauk SSSR, 156: 57-60(May-June, 1964). (In Russian)

The role of neutrino emission of collapsing stars was examined. The neutrino emission originates primarily in the center of the stars. The phenomenon does not involve either the Doppler effect or changes in the body angle. The trajectory of the radially emitted neutrino or light radiation can be conveniently determined. The intensity of the light is a function of the specific time τ at the start of the radiation in the center of the star and the coordinate time t, connected with the passage of the same radiation past a remote nonmoving observer. The red shift, i.e., the energy change of an individual neutrino moving from the gravitational potential well toward the observer, must be also taken into account. It is concluded that although the collapse, as observed externally, continues for a long time period, the characteristic time of the decrease of the luminosity is extremely small, being equal to the radius of the star, divided by the speed of light. For the Sun, $r_0 \cong 3 \times 10^5$ cm and the luminosity decreases by a factor of e in 10^{-5} sec. The mass lost by stars as a result of the emission of neutrinos during the collapse is tabulated. (TTT)

37835 THE PROTON-PROTON CYCLE AND SOLAR NEUTRINOS. G. E. Kocharov (Ioffe Inst. of Physics and Tech., Leningrad). Dokl. Akad. Nauk SSSR, 156: 781-4 (June 1, 1964). (In Russian)

The energy spectrum and intensity of solar neutrinos depends on the reactions taking place within the sun. With a p-p cycle and a C-N cycle there are the following reactions: $^1H(^1H,e^+\nu)^2D$ with a neutrino $E_{max} = 0.42$ Mev; $^2D(^1H,\gamma)^3He$; $^3He + {}^3He \rightarrow {}^4He + 2^1H$; $^7B + e^- \rightarrow {}^7Li + \nu$; $^7Li + {}^1H \rightarrow 2^4He$; $^3He + {}^4He \rightarrow {}^7Be + \gamma$; $^7Be + {}^1H \rightarrow {}^8B + \gamma$; $^8B \rightarrow {}^8Be + e^+ + \nu$; and $^8Be \rightarrow 2^4He$. A 0.86-Mev neutrino is formed during electron capture by ^7Be, and a neutrino with $E_{max} = 13.6$ Mev is formed during decay of ^8B. With the assumption that the weight concentration of hydrogen $X_H = X_{He} = 0.47$, the weight concentrations of ^2D, ^3He, ^7Be, ^7Li, and ^8B with respect to hydrogen were computed at solar temperatures of 5×10^6 to 20×10^6°K. The contribution of 13.6-Mev neutrinos from the 6th and 7th reactions rapidly increases with increasing temperature of the sun. Neutrinos can also be formed by the following series of reactions: $^3He + {}^1H \rightarrow {}^4Li + \gamma$, and $^4Li \rightarrow {}^4He + e^+ + \nu$. A neutrino with $E_{max} = 18.9$ Mev is formed in this reaction. The neutrino emission of stars with a varying central temperature can be estimated from the tabulated data. The reaction rate or product of the neutrino flux by the reaction cross section is plotted for the $^{37}Cl(\nu,e^-)^{37}Ar$ reaction as a function of the central solar temperature, and from the latest results of Davis reported in Bull. Am. Phys. Soc., 4: 4, 217(1959), it can be seen that the center temperature of the sun is $> 25 \times 10^6$°K, and that there is a C-N cycle along with a p-p cycle in the sun. (TTT)

37836 K SHELL CONVERSION COEFFICIENTS IN Ho^{165}, Tm^{169}, Ta^{181} AND Yb^{170}. B. W. Hooton (Univ. of Manchester, Eng.). Nucl. Phys., 59: 341-52(Oct. 1964).

Measurements were made of K shell conversion coefficients in ^{165}Ho, ^{169}Tm, ^{181}Ta, and ^{171}Yb by detecting γ and

x rays. The results are in agreement with theoretical values. A correction for escaping x rays produced by photoelectric absorption of γ rays, which is a possible explanation of some previously reported high values for α_K, is discussed. (auth)

37837 ON THE DENSITY OF METEOROIDS. II. THE DENSITY OF FAINT PHOTOGRAPHIC METEORS. F. Verniani (CNR, Rome and Smithsonian Astrophysical Observatory, Cambridge, Mass.). Nuovo Cimento (10), 33: 1173-84(Aug. 16, 1964).

The density of 359 photographic meteors, reduced by Hawkins and Southworth, was computed with a procedure that uses the height of maximum light and does not require the use of the deceleration. The reliability of the method is discussed. It is shown that neither fragmentation nor other known causes can have a large effect on the results. The meteoroids turn out to have a mean density much smaller than 1 g cm^{-3}. The average density of the sporadic meteors, according to the analysis, is about 0.2 g cm^{-3}. The densities of the members of the principal showers have also approximately the same value. These low densities conform to expectation on the basis of Whipple's icy-comet model and agree with the porous and crumbling structure shown by all photographic meteors but the brightest fireballs. The meteor density obtained in the analysis is essentially the same as that previously obtained for the photographic meteors precisely reduced by Jacchia. It is confirmed that short-period meteors have on the average a greater density than meteors with elongated orbits. No conclusive evidence was found in the Hawkins-Southworth material for any meteor of definite asteroidal origin. (auth)

37838 ON THE NEUTRINO ENERGY DENSITY IN THE UNIVERSE AND A POSSIBLE EXPERIMENT GIVING AN UPPER LIMIT. D. Boccaletti, V. de Sabbata, and C. Gualdi (Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo Cimento (10), 33: 1216-19(Aug. 16, 1964).

Estimates on the energy density of neutrinos in the universe are given considering among the various processes of neutrino pair production the process $e^- + e^+ \rightarrow \nu + \bar{\nu}$ which seems to be the most effective at stellar temperatures around 10^9°K. Reactions of the type $\nu + {}^{40}K \rightarrow {}^{40}Ca + e^-$ are considered for determining the upper limit of the neutrino density. (C.E.S.)

Atomic Physics

37839 (NP-14223) CROSS-SECTIONS FOR CHARGE EXCHANGE REACTIONS. $H^+ + H(n_1\ell_1m_1) \rightarrow H(n_2\ell_2m_2) + H^+$. Robert M. May (Sydney. Univ. School of Physics). May 1964. 42p. (TR-10)

A theoretical discussion of charge-exchange reactions of the type $H^+ + H(n_1\ell_1m_1) \rightarrow H(n_2\ell_2m_2) + H^+$ is presented using Born approximation. The case where the final atom is in a highly excited state is considered. Many of the results are general, and some are exact (in Born approximation). (auth)

37840 (AEC-tr-6398(p.271-87)) ON THE CHARGE, MASS, AND ENERGY BALANCE IN THE COLLISION OF SLOW IONS WITH ATOMS OF SOLIDS. U. A. Arifov. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: (1961).

Methods and procedures for studying ion-atom interactions in solids, including scattering, evaporation, diffusion, cathode atomization, thermoelectric emission, adsorption, absorption, and ion neutralization, are discussed. (R.E.U.)

37841 HFS ATOMIC SCATTERING FACTORS. H. P. Hanson (Univ. of Texas, Austin), F. Herman, J. D. Lea, and S. Skillman. Acta Cryst., 17: 1040-4(Aug. 20, 1964).

Atomic scattering factors calculated from carefully computed Hartree-Fock-Slater wave functions are presented for the neutral elements from Z = 2 to Z = 100 over a range of sin θ/λ values up to 6.0. Because of the nature of the wave functions used and because of the range and density of the parameters for which the calculations were made, this compilation should represent the most complete and most accurate f values available. (auth)

37842 SECOND-ORDER Z-DEPENDENT THEORY OF MANY-ELECTRON ATOMS. David Layzer, Zdeněk Horák, Margaret N. Lewis, and Daniel P. Thompson (Harvard Univ., Cambridge, Mass.). Ann. Phys. (N. Y.), 29: 101-24(Aug. 1964).

A quantitative description of complex term spectra requires accurate knowledge of the three leading coefficients in the Z expansions $E = E_0Z^2 + E_1Z + E_2 + E_3Z^{-1} + \cdots$ of term energies. The screening approximation yields exact values for E_0 and E_1 but only estimates of the remaining expansion coefficients. The coefficient E_2, which may be split up into two physically and mathematically distinct components, E_2' and E_2'', is considered. The intermediate states that figure in the perturbation formulas for E_2' and E_2'' differ from the initial state in one and two principal quantum numbers respectively. The Hartree-Fock and extended Hartree-Fock approximations to E_2 prove to be successive approximations to the component E_2'. E_2^{HF}, E_2^{EHF}, and E_2' can all be readily evaluated directly from their perturbation formulas. Examples of such calculations are given, and the results are compared with the results of conventional calculations of the same quantities. The component E_2'' can be expressed as a linear combination of values of E_2'' for two-electron states in a manner first described, schematically, by Bacher and Goudsmit. For two-electron states, the coefficient E_2 can be evaluated by existing techniques, and from E_2 one easily obtains E_2''. By means of published variational calculations of E_2 for the two-electron states $1s^2\ {}^1S$, $1s2s\ {}^1S$, and $1s2s\ {}^3S$, E_2'' is evaluated for the three-electron state $1s^22s\ {}^2S$. The properties of the coefficient E_2, together with considerations based on the screening approximation, enable one to understand why, in low-lying configurations, term-energy patterns appropriate to high degrees of ionization usually persist down to quite low degrees of ionization. First-order calculations of the matrix elements of one-electron operators are shown to correspond in complexity, not to complete second-order energy calculations as one might expect on general perturbation-theoretic grounds, but to calculations of E_2^{EHF}. They can either be based on perturbation expansions which involve single generalized sums of products of hydrogenic radial integrals, or they can be made to depend on the solution of ordinary, inhomogeneous, second-order differential equations. (auth)

37843 DETERMINATION OF ATOMIC ENERGY LEVELS IN THE ELEMENTS $_{73}$Ta TO $_{83}$Bi BY THE PHOTO ELECTRON METHOD. Anders Fahlman and Stig Hagstroem (Uppsala Univ.). Arkiv Fysik, 27: 69-96(1964).

The electron spectroscopic method for the precision measurement of electron binding energies was used to measure the binding energies of the elements from Z = 73 to 83. In all, 70 levels were determined in the L, M, and N shells. For Bi as many as twelve sub-shells were studied. For the first time photoelectron signals were observed, from which a precision determination was made of the M_I sub-shell energy. Using the photoelectron data, a complete table of electron binding energies for the reported elements was computed. Modified Moseley diagrams are given for the K, L_{II}, L_{III}, M_{II}, M_{III}, M_{IV}, and M_V levels. Experimental data of the spin-doublet splittings

of the $L_{II}-L_{III}$, $M_{II}-M_{III}$, and $M_{IV}-M_V$ levels are compared with the Dirac formula, and screening constants are calculated to fit the experimental data. (auth)

37844 MULTIPLE SCATTERING OF 5-30 kev ELECTRONS IN EVAPORATED METAL FILMS. I. TOTAL TRANSMISSION AND ANGULAR DISTRIBUTION. V. E. Cosslett and R. N. Thomas (Cambridge Univ., Eng.). Brit. J. Appl. Phys., 15: 883-907(Aug. 1964).

The total fraction of the current transmitted and its angular distribution were for the case in which an electron beam is incident normally on evaporated films of Al, Cu, Ag, and Au. The range of mass-thickness investigated was such that plural scattering prevailed in the thinnest, and diffusion conditions in the thickest films. The energy of the incident beam was varied between 5 and 30 kev. The experimental results are not explained in quantitative detail by any of the existing theories. (auth)

37845 GROUND STATE OF TWO-ELECTRON ATOMS AND IONS. A. M. Ermolaev and G. B. Sochilin (Leningrad State Univ. and Leningrad Inst. of Mathematics). Dokl. Akad. Nauk SSSR, 155: 1050-3(Apr. 11, 1964). (In Russian)

An accurate analysis of S-state equations in the vicinity of triple interactions $r_1 = r_2 = 0$ was performed by V. A. Fok (Izv. Akad. Nauk Ser. Fiz., 18: 161(1954)). The nonrelativistic 1^1S states of the H^-, Li^+, Be^{2+}, Be^{3+}, O^{6+}, and Ne^{8+} were investigated using the Fok method and considering the singularities in the wave equation with potential particle interactions in the $V(r_1, r_2, r_{12}) = -Z(r_1^{-1} + r_2^{-1}) + r_{12}^{-1}$ system. (R.V.J.)

37846 SOME EXCITED STATES OF THE HYDROGEN MOLECULE. II. $^1\Pi_g(1s2p\pi)$, $^3\Pi_g(1s2p\pi)$, $^1\Delta_g(1s3d\delta)$, $^3\Delta_g(1s3d\delta)$, $^1\Delta_u(1s3d\delta)$, $^3\Delta_u(1s3d\delta)$. J. C. Browne (Univ. of Texas, Austin). J. Chem. Phys., 41: 1583-6(Sept. 15, 1964).

Complete theoretical potential curves for the bound $^1\Delta_g(1s3d\delta)$ and $^3\Delta_g(1s3d\delta)$ states of H_2 and for the long-range portions of the repulsive $^1\pi_g(1s2p\pi)$, $^3\pi_g(1s2p\pi)$, $^1\Delta_u(1s3d\delta)$, and $^3\Delta_u(1s3d\delta)$ states of H_2 are reported. Comparison of these results plus results from Paper I of this series to the conventional perturbation theory computations for the long-range interactions of those states shows that the conventional perturbation results may be misleading if valence and overlap forces are not considered. The computed total energies at R_e for the $^1\Delta_g(1s3d\delta)$ and $^3\Delta_g(1s3d\delta)$ states are −0.6570143 (−0.65778), and −0.6571785 (−0.65872 au), respectively. The values in parentheses are experimental values. Spectroscopic constants and expectation values for some one-electron operators for the $^1\Delta_g(1s3d\delta)$ and $^3\Delta_g(1s3d\delta)$ states are also presented. Two-center and one-center wavefunctions yielding comparable energies for the $^1\Delta_g(1s3d\delta)$ state are compared through expectation values for a series of one-electron operators. (auth)

37847 REFORMULATION OF THE VIRIAL SERIES FOR CLASSICAL FLUIDS. Francis H. Ree and William G. Hoover (Univ. of California, Livermore). J. Chem. Phys., 41: 1635-45(Sept. 15, 1964). (UCRL-7602)

The usual graphical representation of the virial coefficients is reformulated in terms of graphs containing not only Mayer f functions, but also $\bar{f}$ functions [$\bar{f} \equiv f + 1 \equiv \exp(-\phi/kT)$]. This reformulation has three main advantages: The number of integrals of topological graphs contributing to the virial coefficients is reduced; this simplifies numerical calculations. In Mayer's formulation none of the star integrals contributing to the virial coefficients (for hard potentials, at least) could be ignored; each made a nonnegligible contribution. In the new formulation (again, for hard potentials) many integrals make negligible (or even zero) contributions; the extensive cancellation of positive and negative terms found in Mayer's formulation is reduced. Several new ways of summing the virial series by successive approximation are suggested by the new formulation. One such way is worked out, in the first three approximations, for gases of hard parallel squares and cubes; the third approximation reproduces the first five virial coefficients exactly. The reformulation is not restricted to the virial series alone. The treatment is also generalized to the radial distribution function. It can be applied to any series whose coefficients are integrals of graphs. (auth)

37848 ONE-CENTER WAVEFUNCTION FOR THE GROUND STATE OF THE HeH^+ MOLECULAR ION. J. D. Stuart and F. A. Matsen (Univ. of Texas, Austin). J. Chem. Phys., 41: 1646-50(Sept. 15, 1964).

The HeH^+ molecular ion is a member of that class of diatomic hydride molecular ions that are one-center systems at $R = 0$ and at $R = \infty$. The total electronic energy of the ground state of HeH^+ was calculated over a wide range of R with a 30-term orbital product wavefunction centered on the helium nucleus. The results are compared with a James and Coolidge-type calculation and with a two-center orbital product calculation. The results in the order Evett, Anex, and present calculation are R_e = 1.432, 1.446, 1.464 au; ω_e = 3600, 3378, 3184 cm^{-1}; and E(R = 1.4 au) = −2.9730, −2.9742, −2.9691 au. The energy of the present calculation is the lowest for R greater than about 2 au and is lower than the classical polarization energy for $2 < R < 4$ au. For $R > 4$ au the one-center interaction energies [$E(R) - E(\infty)$] lie quite close to the classical polarization energies. (auth)

37849 PARTIAL IONIZATION CROSS SECTIONS FOR NOBLE GASES BOMBARDED WITH 0.8-3.75-Mev PROTONS. S. Wexler (Argonne National Lab., Ill.). J. Chem. Phys., 41: 1714-19(Sept. 15, 1964).

The partial cross sections for the production of noble-gas ions in their various charge states were determined for He, Ne, Ar, and Kr bombarded by protons in the energy range from 0.8 to 3.75 Mev. The slow ions formed in the collisions of the swiftly moving hydrogen ions with the isolated noble-gas atoms were extracted in a direction at right angles to the proton beam. Their charge and intensity were analyzed by means of a portable mass spectrometer with special constructional features. The data were combined with values of the total ionization cross sections determined by Hooper et al. to evaluate the partial cross section for the formation of each species. The cross sections were compared with those previously obtained by others for proton projectiles with energies between 5 and 180 kev. (auth)

37850 OPTICAL EMISSION FROM ARGON EXCITED BY ALPHA PARTICLES: QUENCHING STUDIES. T. D. Strickler and E. T. Arakawa (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 41: 1783-9(Sept. 15, 1964).

Optical emission from argon gas excited with alpha particles was studied to determine if electronic states of long lifetimes are excited by swiftly moving charged particles as has been observed in studies of ionization. The spectrum from argon showed a continuum that could be separated into three distinct bands with maxima at 1300, 1800, and 2000 Å. The light intensity of the 2200-Å band was readily quenched with the addition of about 2% of CH_4, CO_2, O_2, and Kr. The 1800-Å band was quenched more slowly than the 2200-Å band by the impurity gases. The results support the notion that alpha-particle excitation of argon at high pressures leaves the argon in long-lived states of about 11.5 or 14.5 ev. The observed continua appear to arise mainly from Franck-Condon transitions between two

excited states and the ground repulsive state of the argon dimer, which forms as a consequence of the long lifetimes of the excited atoms. (auth)

37851 OBSERVED LINE SHAPES OF COLLECTIVE EXCITATIONS IN Al, Be, AND Ge. N. Swanson (National Bureau of Standards, Washington, D. C.). J. Opt. Soc. Am., 54: 1130-3(Sept. 1964).

Line shapes of the major characteristic electron energy-loss peaks of Al, Be, and Ge, attributed to collective excitations of the valence electrons, were measured at 20 kev primary electron energy and zero scattering angle. The primary-beam line shape was unfolded from the observed energy-loss peak to obtain the natural-loss line shape. The results are discussed in terms of a Lorentzian line and the Drude model. The unfolded line shapes of Al and Ge are compared with optical measurements of $-\mathrm{Im}(1/\epsilon)$. An expected correlation between the loss-peak halfwidth and the value of ϵ_2 at the peak maximum is in fair agreement with the observed data for Al and Ge. (auth)

37852 RESULTS ON SMALL-ANGLE SCATTERING OF ELECTRONS IN GASES. J. Kessler (Technische Hochschule, Karlsruhe, Ger.). Phys. Letters, 11: 230 (Aug. 1, 1964).

The differential cross sections for electron elastic scattering from rare gases (z = 10, 18, 36 and 54) at small angles were determined absolutely from previous experiments with 100-kev electrons. The results were compared with the predictions of Lenz's theory. (D.C.W.)

37853 SPUTTERING YIELDS OF SILVER AND ANGULAR DISTRIBUTION OF THE ATOMS SPUTTERED BY IONS OF NOBLE GASES. S. B. Karmohapatro and A. V. Narasinham (Saha Inst. of Nuclear Physics, Calcutta). Proc. Natl. Acad. Sci. India, Sect. A, 33: 629-34(1963).

The angular distributions and yields of sputtered atoms were measured as functions of ion energy and mass, using He, Ne, Kr, and Xe ions at energies of 3 to 7 kev. The results were compared with previous observations, and the mass dependence of the sputtering yield was analyzed by the hard-sphere collision model. (D.C.W.)

37854 GENERAL DISTORTED-WAVE TREATMENT OF ROTATIONAL TRANSITIONS IN MOLECULAR COLLISIONS. W. D. Davison (Queen's Univ., Belfast). Proc. Roy. Soc. (London), Ser. A, 280: 227-34(July 21, 1964).

An iterative procedure is described for the determination of the cross sections for rotational transitions in the collision of two diatomic molecules. The first iteration yields the familiar distorted-wave (d.w.) approximation, which was previously applied to the two principal transitions in parahydrogen. The iteration was carried a stage further, yielding what may be termed the second d.w. approximation with the use of the same intermolecular potential function as gave reasonable agreement with experiment in the previous circulation; it is found that the cross sections at thermal energies are decreased by about 8%. It is therefore concluded that the first d.w. approximation is adequate for the treatment of rotational relaxation in hydrogen at and below room temperatures. (auth)

37855 CONDENSATION EMBRYOS IN AN EXPANDING GAS BEAM. R. E. Leckenby, E. J. Robbins, and P. A. Trevalion (United Kingdom Atomic Energy Authority, Risley, Lancashire, Eng.). Proc. Roy. Soc. (London), Ser. A, 280: 409-29(July 28, 1964).

Polymeric molecules were observed in the mass spectra of several gases expanding isentropically from a high-pressure reservoir into a vacuum. The possible origins of these complex molecules were examined and it is concluded from the experimental evidence that they are condensation embryos forming in the cooled, supersaturated gas. Some interesting features of the condensation process are highlighted; in particular the formation of mixed polymers, such as $Ar \cdot CO_2$ in expanding gas mixtures, and the preferential formation of even-numbered polymers, $(H_2O)_2$ and $(H_2O)_4$, in condensing steam. (auth)

37856 DEVELOPMENT OF AN ELECTRON AVALANCHE WITH OVERVOLTAGES IN N_2. PART 2. STREAMER FORMATION. H. Tholl (Universität, Hamburg). Z. Naturforsch., 19a: 704-15(June 1964). (In German)

In N_2 and N_2 with a small amount of CH_4 the transition of an electron avalanche into the streamer formation (anode- and cathode directed streamers) was investigated under pulsed homogeneous field conditions. The temporal development of this transition was measured at different overvoltages using photomultiplier techniques and by photographing the discharge itself. By comparison of oscillograms and photographs the velocities of the anode directed streamers, which start at carrier amplifications of $\cong 10^8$, as well as the velocities of the cathode directed streamers were determined confirming the cloud chamber measurements. The anode directed streamer starts already in the region in which the carrier amplification is still reduced by the space charge of the avalanche itself. The cathode directed streamer always starts some nsec later. At the beginning of the development of the cathode directed streamer a small brightly shining neck appears in the region of the increased ionic space charge field of the avalanche, which can still be seen in later stages of the spark development. (auth)

37857 PHOSPHORESCENCE OF Ar, N_2 AND N_2 WITH CH_4 AFTER EXCITATION IMPACTS THROUGH ELECTRON AVALANCHES. K. H. Wagner (Universität, Hamburg). Z. Naturforsch., 19a: 716-21(June 1964). (In German)

In a pulsed discharge gap the blue and near uv radiation due to exciting impacts caused by electron avalanches is investigated. Cutting-off the gap voltage rapidly stops the avalanche process but not the light emission which shows an exponential decay, the decaytime τ being pressure dependent (quenching process). By extrapolation to zero pressure mean lifetimes of the observed excited states are obtained (N_2: $\tau_0 = 36 \cdot 10^{-9}$ sec; Ar: $\tau_0^{\mathrm{I}} = 1{,}5 \cdot 10^{-6}$ sec, $\tau_0^{\mathrm{II}} = 2 \cdot 10^{-8}$ sec). In argon yet another state (II) is detected which fills up the lower radiating state (I) ($\tau_0^{\mathrm{II}} = 0{,}7 \cdot 10^{-6}$ sec). The excitation of state (II) is favored by raising E/p of the preceding avalanche discharge. Quenching in argon is insignificant (quenching probability $w' < 10^{-3}$) while in nitrogen we obtain $w' \approx 5 \cdot 10^{-2}$ from the measured quenching pressure $p' = 58$ Torr. The N_2 radiation is very much effected by addition of methane: Practically every impact with a methane molecule leads to quenching of the excited N_2 molecules. (auth)

37858 THE QUESTION OF THE GROUND STATE IN THE Tb I SPECTRUM. P. F. A. Klinkenberg (Universiteit, Amsterdam). Z. Physik, 180: 174-7(1964). (In German)

Analysis of the optical spectrum of Tb I confirms the conclusion reached by Bender, Penselin, and Schlüpmann from atomic beam magnetic resonance observations, that the lowest multiplet in the $4f^85d6s^2$ configuration is ^8G. The lowest level, however, is not $^8G_{15/2}$, but $^8G_{13/2}$, which is the true ground level of the Tb atom, provided the determination of the relative position of $4f^96s^2\ ^6H_{15/2}$ with respect to $4f^85d6s^2\ ^8G_{15/2}$ by Bender c.s. is correct. (auth)

37859 THERMODYNAMIC AND TRANSPORT PROPERTIES OF NON-EQUILIBRIUM PARTIALLY IONIZED MONATOMIC GASES. Chor-Weng Tan. Thesis, Urbana, Ill., Univ. of Illinois, 1963. 184p.

The system of a partially ionized monatomic gas was treated as a gaseous mixture of atoms, ions, and electrons, individually obeying the ideal gas law, but collectively behaving like one slightly perturbed from the equilibrium condition due to the coexistence of different temperatures in the system. The ion and the atom temperatures, generally, lag far behind the electron temperature throughout the entire process of ionization started and maintained by an applied electric field. The thermodynamic properties of a partially ionized gas were formulated via statistical mechanics with due consideration to the contributions of the various modes of energies of the different particles comprising the ionized gas medium to their corresponding partition functions. The grand canonical ensemble was chosen for this reactive system. The non-equilibrium phenomena were accounted for by the introduction of the parameter η_{ps} which is a measure of the deviation of the electron temperature from the gas temperature. Four different potential models were adopted to describe the six different types of binary collisions in a three-component partially ionized gas. The Chapman-Enskog formulation of the transport properties, simplified by Hirschfelder, Curtiss, and Bird, was employed in the determination of the transport properties of a partially ionized gas. The contribution of ambipolar diffusion to the thermal conductivity proved to be of great significance, especially at lower temperatures ($\sim 10^4$ °K). Close correlations of experimental results with theory on the relations of the electron temperature, the gas temperature, the extent of ionization and the applied electric field were observed. It was also shown that treating the apparent properties of an ionized gas with deviation of the electron temperature from the atom and the ion temperatures as a small perturbation from the classical case is a feasible one at low extent of ionization. (Dissertation Abstr., 24: No. 12, Pt. I (June 1964))

37860 LOCALIZED MODE DETECTION BY MEANS OF THE MÖSSBAUER EFFECT. Alvin David Dinhofer. Thesis, College Park, Md., Univ. of Maryland, 1963. 44p.

The possible use of the Mössbauer effect to detect localized vibrational modes in a crystal is discussed. A simple cubic crystal with a centrally located isotopic, light, Mössbauer impurity in a host of non-resonant nuclei is considered first. A normal mode expansion is obtained, which approximates the motion of the light impurity. The contribution to this expansion of the single, isolated, localized mode, found by Montroll, is calculated. The absorption cross section for photons capable of exciting localized mode phonons, in being absorbed resonantly by the Mössbauer impurity, is found. The frequency spectrum of a dilute, disordered distribution of Mössbauer, light impurities in a simple cubic crystal is studied. A localized mode band is found and related to the spectrum of the perfect crystal by means of perturbation theory. The cross section is re-calculated for photon absorption with the creation of localized mode phonons in the spectrum of the disordered crystal. The effect of the localized mode bandwidth on the possible use of transmission-type experiments for observing the localized mode spectrum is evaluated. (Dissertation Abstr., 24: No. 12, Pt. I (June 1964))

37861 THEORY OF SPIN RELAXATION. W. J. Caspers. Monographs in Statistical Physics and Thermodynamics. Volume 6. New York, Interscience Publishers, 1964. 169p. $9.75.

Paramagnetic spin relaxation phenomena, the theory of spin-spin relaxation, and the theory of spin-lattice relaxation are discussed. (C.E.S.)

Cosmic Radiation

37862 (A/CONF.28/P/358) NEUTRON PHYSICS PARAMETERS OF SOME WATER-MODERATED URANIUM LATTICES. L. G. Andreev, I. H. Ganev, S. I. Garanin, et al. (U.S.S.R.). May 1964. 18p.

A study was made of U–H_2O lattices having rod-type fuel elements. Results are presented of three independent experiments carried out at the Kurchatov Atomic Energy Institute and certain problems involved in calculation of parameters of uranium–water systems. Critical experiments with lattices at 7, 8, and 14 mm spacings, with and without absorbers, are described. An investigation was conducted of the parameters of lattices with spacings 13, 15, 17, and 19 mm, and with the elements made of sintered natural urania (fuel element diameter, 9.4 mm and cladding, 0.7 mm aluminium). A 60-mm spaced lattice with uranium–magnesium ceramic (fuel element diameter –35 mm, magnesium weight content –17.8%, enrichment –2%, cladding –1 mm aluminium) was subjected to an investigation of the dependence of the neutron flux relaxation time on the height and radius of the assembly in a wide range of the geometrical bucklings. (auth)

37863 (AFCRL-64-394) COSMIC RAY INTENSITY VARIATIONS DURING 1963. Technical Note No. 3. A. E. Sandstroem, E. Dyring, L. Ekstroem, B. O. Groenkvist, S. Lindgren, and B. Oestman (Uppsala Univ. Inst. of Physics). Mar. 15, 1964. Contract AF61(052)-614. 33p. (AD-600369)

During 1963 the recorders have continued in Uppsala and Kiruna by one neutron monitor, two cubical telescopes and six inclined telescopes. Tables and figures give a detailed account of diurnal and semidiurnal variations during the year. A sharp phase shift in the semidiurnal variation can be found for the neutron monitor. Five decreases are illustrated by bihourly diagrams. (auth)

37864 INTERACTIONS OF COSMIC-RAY MUONS. S. H. Neddermeyer (Univ. of Washington, Seattle). p.393-4 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

The results of observations of events in carbon targets (hard collisions of mesons(μ) with electrons) and direct measurements of the momentum loss of mesons(μ) incident on a lead target 11-in. thick are summarized. (D.C.W.)

37865 COSMIC-RAY PRODUCED NUCLIDES IN GROUND LEVEL AIR AND IN PRECIPITATION. G. Schumann, W. Roedel, and M. Stoeppler (Universität, Heidelberg). 7p. (CONF-337-36)

From International Conference on Radioactive Pollution of Gaseous Media, Saclay, France, Nov. 1963.

The content of ^{7}Be, ^{22}Na, and ^{35}S in ground level air and precipitation was measured during the period 1960-1963. A strong seasonal variation of the content was attributed to a stratospheric contribution, but evidence for artificial production of the three nuclei in association with nuclear tests was also observed. The relative contributions were considered. (D.C.W.)

Criticality Studies

37866 (A/CONF.28/P/84) CRITICALITY STUDIES. Denis Breton, Christian Clouet d'Orval, and Pierre Le-

corche (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 15p.

Critical masses of plutonium and uranium solutions in cylinders, annular vessels, and plates were measured under various conditions of concentration, reflection, and interaction. Physical measurements such as spectra and reactor noise were also carried out. Various computation methods (diffusion, transport, and Monte Carlo) were developed, and results compared with experiment. The studies were applied to safety design and control of industrial plants. (M.J.T.)

37867 (A/CONF.28/P/381) THE CRITICAL PARAMETERS OF AQUEOUS SOLUTIONS OF $UO_2(NO_3)_2$ AND NUCLEAR SAFETY. B. G. Dubovskii, A. V. Kamaev, V. V. Orlov, G. M. Vladykov, V. N. Gurin, F. M. Kuznetsov, V. P. Kochergin, I. P. Markelov, G. A. Popov, and V. J. Sviridenko (U.S.S.R.). May 1964. 18p.

Experimental and theoretical investigations on critical parameters of uranium salt aqueous solutions with 90, 10, or 5 per cent enrichment are described. These investigations were carried out for determination of nuclear safety conditions and for studies of homogeneous reactor physics. Critical volumes of the solutions were determined at various uranium concentrations in the range of 30–450 g/l. Extrapolation lengths and effective additions of various reflectors were determined during experiments. The experimental results obtained for cylinder and rectangular cores by transformation of geometrical parameters using the extrapolation length and effective addition of light water reflector, were recalculated for cores having shapes of a sphere, infinite cylinder, and infinite flat layers. (auth)

Direct Energy Conversion

Refer also to abstracts 38392 and 38498.

37868 (A/CONF.28/P/45) PRELIMINARY STUDY OF MHD CONVERTERS OPERATING IN THERMODYNAMIC NON-EQUILIBRIUM. Pierre Ricateau (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 15p.

The development work on closed-cycle MHD converters is described. The possible use of nonuniform flows is being studied. Ionization by electron heating is considered, and experiments on argon seeded with potassium and cesium are described. Planned future experiments are discussed. (D.L.C.)

37869 (A/CONF.28/P/132) FISSION-HEATED THERMIONIC DIODES. P. D. Dunn and J. Adam (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). May 1964. 15p.

The scope and objects of a program on fission-heated thermionic converters are described. Two types of in-pile rigs were operated, one with fixed electrical load and one with a variable electrical load. All these rigs had unclad UC–ZrC rods as emitters and their output current was of the order 10 to 15 amps cm^{-2}. Post-irradiation examination indicates some fuel material was evaporated from the emitter and was deposited on the anode. There are indications that UC evaporates preferentially from the UC–ZrC alloy. Rigs having refractory metal emitters operating at elevated cesium pressures have been constructed, and a rig consisting of four generators in series inside a single envelope has been designed. Fabrication of UC–ZrC fuel, compatibility tests performed on various materials in cesium, and plans for future work on refractory metal-fissile fuel compatibility and ceramic-to-metal seals are discussed. (auth)

37870 (A/CONF.28/P/133) NUCLEAR MAGNETOPLASMADYNAMIC ENERGY CONVERSION. B. C. Lindley (International Research and Development Co. Ltd., Newcastle upon Tyne, England). May 1964. 16p.

Research on closed-cycle magnetoplasmadynamic (MPD) generator systems, employing alkali-metal-seeded inert gases as the working fluid, is at an early stage. The nuclear heat source is the most difficult problem, but a direct gas-cooled reactor may be technically feasible. For thermal ionization, the electrical conductivities of cesium-seeded inert gases are comparable with those of potassium-seeded combustion gases at temperatures about 500°C higher, so that the closed-cycle has an immediate advantage over the coal- or oil-fired open cycle. There also exists the possibility in inert gas plasmas of achieving high electrical conductivities through non-equilibrium ionization at quite moderate gas temperatures (1200 to 1800°C). If operation at such low temperatures is proved, the nuclear closed-cycle scheme becomes much more attractive. An attempt is made to evaluate the closed-cycle MPD concept in terms of technical and economic feasibility, and the associated long-term implications on electrical power generation. A broad research programme, based on a pilot-scale closed-loop helium-cesium facility and a series of supporting plasma physics experiments, has been undertaken at the IRD laboratories. Constructional techniques for circuits operating at gas temperatures up to 2250°C and progress in evaluating the physical processes of MPD generation are described. An assessment of the critical operating parameters, such as overall cycle efficiency and generator power density, is included. (auth)

37871 (A/CONF.28/P/317) THEORETICAL AND EXPERIMENTAL INVESTIGATIONS CONNECTED WITH DEVELOPMENT OF THERMIONIC REACTORS-CONVERTERS. I. I. Bondarenko, I. N. Gorelov, Yu. K. Gus'kov, et al. (U.S.S.R.). May 1964. 20p.

Possibilities of application of thermionic heat-to-power converter in nuclear engineering are discussed for middle- and low-power nuclear reactors. The results of theoretical and experimental investigations of fundamental converter processes in various operating conditions (low-pressure with charge neutralization, low-mean-free-path limit, low-voltage-arc limit) are presented. Physical and technical features of these operating conditions are considered. The results of investigations of surface ionization and thermoelectron emission properties for main refractory and design materials are also presented, including characteristics of thermionic low-pressure converter with charge neutralization. Thermoemission constant values are briefly discussed. Results are given on voltage-current characteristics of the converter in the low-mean-free-path limit, saturation-current and optimal power dependence on the electrode temperature, gas pressure, and emission properties of electrodes. The heat-flux carried over from a cathode by electrons and the converter efficiency are calculated. Some physical parameters of the converter are obtained on the basis of comparison of theoretical and experimental data. The influence of external magnetic field on the thermionic converter and low-voltage-arc is investigated. Results are given concerning theoretical and experimental examinations of current fluctuations of the converter. (D.L.C.)

37872 (A/CONF.28/P/318) RADIOISOTOPE-FUELED THERMOELECTRIC GENERATORS. A. N. Voronin, I. G. Gverdsiteli, and R. S. Orinberg (U.S.S.R.). May 1964. 20p.

The design of a thermoelectric generator operating in vacuum is presented. The description of the isotopic heat source of the thermoelectric generator and the high temperature thermoelectric material base is given. The test method of the device and the test stand description are given. The stand test results (volt-ampere characteristics, temperature distribution, the device activity, etc.) are presented. (auth)

37873 (AERE-R-3757) THE APPLICATION OF ONE-DIMENSIONAL FLUID DYNAMICS TO THE DIRECT-CURRENT PLASMA GENERATOR. J. C. Ralph (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). June 1961. 50p.

An iterative method for solving the fluid flow equations of the d-c plasma generator is presented and in particular a generator operating with constant terminal voltage, constant electrical efficiency, and producing constant output per unit length is considered. An approximate method for calculating the unknown parameters in this particular generator is also given together with curves for obtaining optimum Mach numbers to be used for various values of the plasma-stream total head temperature. It is still too early to draw any final conclusions on the feasibility of magnetogasdynamic power generation on a large scale but present indications are that generators of this type would only be used as "topping" devices where the high-temperature exhaust gases from the generator are passed on to the boiler of the conventional steam cycle. (auth)

Elementary Particles and Radiations

Refer also to abstract 38137.

37874 (64-RL-3604-M) THE INFLUENCE OF THE EXCLUSION PRINCIPLE ON THE SCATTERING THEORY OF NONLOCAL, SEPARABLE POTENTIALS. C. B. Duke (General Electric Co. Research Lab., Schenectady, N. Y.). Mar. 1964. 43p.

The effect of the exclusion principle on the scattering theory of nonlocal, separable potentials is investigated by solving the Brueckner-Bethe-Goldstone (BBG) equation, subject to scattering-theory boundary conditions. The exclusion principle destroys the spherical symmetry of the isolated two-body problem. This symmetry is replaced by axial symmetry about an axis along the center-of-mass momentum of the interacting pair of Fermions. The scattering amplitudes associated with a simple separable potential, which describes low-energy nucleon-nucleon scattering, are calculated. At the observed nuclear density, the scattering amplitudes obtained from the BBG equation (the independent-pair model) differ significantly from those obtained from a solution to the isolated two-body problem (the isolated-pair model). The isolated-pair model fails to give a satisfactory approximation to the independent-pair model for densities as low as one five-hundredth of the observed nuclear density. For repulsive interactions of the same strength and range as the above nucleon-nucleon potential, the real parts of the isolated-pair scattering amplitudes approximate those of the independent-pair scattering amplitudes to within 20% at densities below one-eighth of the observed nuclear density. However, for some two-body kinematics the imaginary part of the independent-pair scattering amplitude is suppressed by a factor of about two relative to its isolated-pair counterpart at densities above one five-hundredth of the observed nuclear density. (auth)

37875 (BNL-8236) A STUDY OF $\pi^- + p \rightarrow K_1^0 + K_1^0 + n$ REACTION AT 6 Bev/c. V. E. Barnes, W. B. Fowler, K. W. Lai, D. Radojicic, D. C. Rahm, and M. S. Webster (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract [AT(30-2)-Gen-16]. 7p. (CONF-550-29)

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

Preliminary results on π^- – p interactions at 6 Bev/c in a liquid-hydrogen bubble chamber are reported. A Dalitz plot of the unambiguous events ($K_1^0K_1^0n$) is shown. (R.E.U.)

37876 (BNL-8248) FINAL-STATE INTERACTIONS IN $\pi^+ + p$ COLLISIONS AT 2.77 Bev/c. S. S. Yamamoto, J. R. Smith, D. C. Rahm, and J. J. Lloyd (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract [AT(30-2)-Gen-16]. 7p. (CONF-550-28)

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

Four-prong bubble chamber events from 2.77-Bev/c mesons(π^+) were analyzed. Effective mass distributions are shown. (R.E.U.)

37877 (CERN-64-33) METHODES POUR LA DETERMINATION DU SPIN ET DE LA PARITE DES RESONANCES. (Methods for the Determination of the Spin and Parity of Resonances). Mary K. Gaillard (European Organization for Nuclear Research, Geneva). July 8, 1964. 53p.

The determination of the spin and parity of resonances depends, in a complicated manner, on the angular distributions in the production and decay of these states. Up to the present there has been no definitive result on strange resonances. The utilization of a polarized target would provide information essential for the study of angular correlations. The methods used previously (non-polarized target) for such determinations and the technical possibilities for the use of a polarized target are discussed. The use of a polarized target to permit the determination of the spin and parity of resonances was studied in detail. (tr-auth)

37878 (LNF-64/23) PROGRAMMI DI CALCOLO DELLE CINEMATICHE DELLE REAZIONI A DUE CORPI E A TRE CORPI PER IL CALCOLATORE IBM 1620. (Program for Calculation of the Kinematics of Two-Body and Three-body Reactions on the IBM-1620 Computer). Note No. 244. G. Verri (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). May 27, 1964. 14p.

A program for kinematic calculations for two- and three-body interactions of the types $a + b \rightarrow c + d$ and $a + b \rightarrow c + d + e$, respectively, is discussed. Decay, photoproduction, elastic, and inelastic scattering may be considered. (R.E.U.)

37879 (NP-14173) DIFFUSION ELASTIQUE e-D ET STRUCTURE ELECTROMAGNETIQUE DU NEUTRON. ((e-d) Elastic Scattering and Electromagnetic Structure of the Neutron). D. Treille (France. Centre National de la Recherche Scientifique, Paris). [nd]. 107p.

Thesis submitted to Université, Paris.

An attempt was made to determine the distribution and sign of charges in the neutron for a weak momentum-transfer interaction ($q^2 = 1$). The cross section for the elastic electron-deuteron scattering was determined with precision (3%) by using a solid target of deuterated poly-

ethylene. Then because of a theoretical study of this scattering and because values of form factors for the proton measured in experimental conditions very similar to the present ones, the value of the electric form factor of the neutron was determined as 0.015 ± 0.009. (J.S.R.)

37880 (TID-20952) LEPTONIC DECAYS OF CHARGED SIGMA HYPERONS AND THE $\Delta S = \Delta Q$ SELECTION RULE. Technical Report No. 394. H. Courant (European Organization for Nuclear Research, Geneva); R. Engelmann (Heidelberg. Universität); R. A. Burnstein (Maryland Univ., College Park and Naval Research Lab., Washington, D. C.); W. Willis, et al. (Brookhaven National Lab., Upton, N. Y.). Aug. 1964. Contract [AT(40-1)-2504]. 46p.

Leptonic decays of Σ^+ and Σ^- hyperons were searched for in a sample of about 500,000 $\Sigma^\pm$ decays. This report is based on the observation of 130 $\Sigma^\pm$ leptonic decays of various types. The principal results are: (a) no evidence for $\Delta S = -\Delta Q$ Σ^+ leptonic decays, with the upper limit with 90% confidence for the ratio of $\Delta Q = -\Delta S$ to $\Delta Q = +\Delta S$ transitions equal to 0.12; (b) $(\Sigma^- \rightarrow \Lambda + e^- + \nu/\Sigma^- \rightarrow n + \pi^-) = (0.75 \pm 0.28) \times 10^{-4}$; (c) $(\Sigma^- \rightarrow n + e^- + \nu/\Sigma^- \rightarrow n + \pi^-) = 1.4 \pm 0.3 \times 10^{-3}$; and (d) $(\Sigma^- \rightarrow n + \mu^- + \nu/\Sigma^- \rightarrow n + \pi^-) = 0.66 \pm 0.14 \times 10^{-3}$. The data are consistent with $(\mu\nu)$, $(e\nu)$ universality for $\Sigma^- \rightarrow n + l^- + \nu$ decays and with the $\Delta I = 1$ rule for $\Sigma^\pm \rightarrow \Lambda + e^\pm + \nu$ decays. A comparison is made between experiment and Cabibbo's theory of weak interactions. Acceptable agreement is found for Cabibbo's angle θ close to 0.26 and with the axial vector (F/D) ratio approximately equal to ½ or 2. (auth)

37881 (UCRL-7899) ON COLLISIONS INVOLVING MOVING TARGET-PARTICLES. George Kramer and John Terrall (California. Univ., Livermore. Lawrence Radiation Lab.). May 1964. Contract W-7405-eng-48. 9p.

The importance of the relative velocity of colliding particles in establishing the fundamental direction from which cms angles of emission are measured is emphasized. One must counteract the habit, which stems from the zero-target-velocity case, of measuring cms angles from the direction of the c-m motion or from the incoming particle direction. It is shown that the transcription from zero to nonzero target-particle velocity can be made merely by replacing the incoming particle velocity by the relative velocity and then, after calculating outcoming velocities, adding on the target velocity. In case any one velocity is relativistic, the procedure is not this simple of course, since velocity vectors no longer add in a simple way. (auth)

37882 (UCRL-11437) K_{e4} DECAYS AND THE DETERMINATION OF LOW-ENERGY PION-PION PHASE SHIFTS. Nicola Cabibbo and Alexander Maksymowicz (California. Univ., Berkeley. Lawrence Radiation Lab.). June 16, 1964. Contract W-7405-eng-48. 9p. (CONF-550-27)

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

Angular correlations in the decay $K^+ \rightarrow \pi^+\pi^-e^+\nu$ and their relevance to the determination of $\pi-\pi$ phase shifts are discussed. Model calculations of the correlations are also given. (auth)

37883 (UCRL-11441) PROTON-PROTON ELASTIC SCATTERING. A. R. Clyde, Bruce Cork, D. Keefe, L. T. Kerth, W. M. Layson, and W. A. Wenzel (California. Univ., Berkeley. Lawrence Radiation Lab.). July 10, 1964. Contract W-7405-eng-48. 13p. (CONF-550-22)

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

Differential cross sections for elastic proton-proton scattering were measured for incident momenta of 3, 5, and 7 Bev/c. The protons scattered backwards in the cms are detected with scintillation counters following analysis with a magnetic spectrometer. Polyethylene and carbon targets were used for scattered momenta between 500 and 4000 Mev/c, and a gaseous hydrogen target was used for scattered momenta below 600 Mev/c. With a few exceptions, the statistical errors are smaller than 1% for the lower momentum transfers, and increase to 5% for 90° scattering in the center-of-mass. The cross sections at high momentum transfer are nearly independent of momentum transfer but depend upon incident energy, a result consistent with experiments at higher energy. (auth)

37884 (UCRL-11442) PRODUCTION OF STRANGE-PARTICLE RESONANT STATES IN π^- + p INTERACTIONS AT 3.2 AND 4.2 Gev/c. Lyndon M. Hardy, Suh Urk Chung, Orin I. Dahl, Richard I. Hess, Janos Kirz, and Donald H. Miller (California. Univ., Berkeley. Lawrence Radiation Lab.). July 3, 1964. Contract W-7405-eng-48. 14p. (CONF-550-9)

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

The general properties of the three- and four-body final states containing a Λ or $\Sigma^{\pm,0}$ are being studied at 3.2 and 4.2 Bev/c. The meson and baryon resonances that contribute most significantly to these final states are considered. Evidence is presented for the increasing importance of peripheral collisions involving boson exchange as the incident π^- momentum is raised. (auth)

37885 (UCRL-11465) K^+d INTERACTIONS AT 2.3 Bev/c. Sulamith Goldhaber, Ian Butterworth, Gerson Goldhaber, Allan A. Hirata, John A. Kadyk, Thomas A. O'Halloran, Benjamin C. Shen, and George H. Trilling (California. Univ., Berkeley. Lawrence Radiation Lab.). July 24, 1964. Contract W-7405-eng-48. 13p. (CONF-550-41)

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

An experimental study of vector-meson exchange in reactions $K^+ + p + (n) \rightarrow K^0 + \pi^+ + p + (n)$ and in $K^+ + n + (p) \rightarrow K^+ + \pi^- + p + (p)$ at 2.3 Bev/c was made. The $(K\pi)$ resonances were investigated. (R.E.U.)

37886 (UCRL-11468) DI-PION MASS SPECTRUM FROM π^-p COLLISIONS AT 4 Bev/c. D. Keefe, L. T. Kerth, C. M. Noble, J. J. Thresher, W. A. Wenzel, and T. F. Zipf (California. Univ., Berkeley. Lawrence Radiation Lab.). July 10, 1964. Contract W-7405-eng-48. 10p. (CONF-550-19)

From International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

The final-state $\pi-\pi$ interaction in the process $\pi^- + p \rightarrow \pi^+ + \pi^- +$ (missing mass) was studied at an incident momentum of 4 Bev/c by means of a magnetic spectrometer using spark chambers. A lead and scintillator "sandwich" counter system surrounding part of the hydrogen target rejected highly inelastic events to enhance detection of the $\pi^+\pi^-$n final state. About 2000 out of the 6000 measured two-prong events were identified as $\pi^+\pi^-$n. With a resolution in missing mass of ± 90 Mev, the $\pi^+\pi^-$n+(nπ^0) background in the $\pi^+\pi^-$n sample is reduced to a few percent. The resolution in the di-pion mass is less than ±20 Mev. (auth)

37887 (UCRL-11500) REGGE BEHAVIOR OF THE SPINOR CHANNEL IN THE VECTOR-SPINOR THEORY. S. Mandelstam (California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Berkeley). June 15, 1964. Contract W-7405-eng-48. 8p. (CONF-550-18)

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

The potential in the vector meson-spinor theory of elementary particle interactions is investigated to find why the Kronecker-delta terms are unnecessary in the reggeized scattering amplitude as Gell-Mann, Goldberger, Low, Marx, Singh, and Zachariasen suggest. The elastic-unitarity approximation is used. (R.E.U.)

37888 (UCRL-11550) THE REACTION $n + n \rightarrow n + p + \pi^-$ AT 1.9 Gev/c. Robert Birge, Robert Ely, George Gidal, George Kalmus, Anne Kernan, and Sedong Kim (California. Univ., Berkeley. Lawrence Radiation Lab.). July 4, 1964. Contract W-7405-eng-48. 11p. (CONF-550-11)

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

An analysis of 503 $n + n \rightarrow n + p + \pi^-$ events at 1.7 to 2.3 Bev/c was made to test charge symmetry and also to show the feasibility of observing n-n reactions at well-defined Bev energies. A deuterium bubble chamber was exposed to 3.68 Bev/c deuterons and events ($2p + \pi^-$) were identified in which the proton of the target nucleus acts as a spectator. The neutron was assumed to be at rest for $d + n \rightarrow 2p + n + \pi^-$; the n-n reactions were identified by having $\chi^2 \leq 3$, and by protons present in the rest frame of the deuteron beam of less than 120 Mev/c. (R.E.U.)

37889 (UCRL-11553) ANALYSIS OF THE DECAY $K^+ \rightarrow \pi^0 + e^+ + \nu$. George E. Kalmus, Anne Kernan (California. Univ., Berkeley. Lawrence Radiation Lab.); Ugo Camerini (Wisconsin. Univ., Madison); and Cyril Henderson (London. Univ. University Coll.). July 7, 1964. Contract W-7405-eng-48. 9p. (CONF-550-17)

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

The decay $K^+ \rightarrow \pi^0 + e^+ + \nu$ was studied in a freon bubble chamber. The film was scanned for the possible K^+_{e3} decays. (R.E.U.)

37890 THE BOUNDARY CONDITION MODEL OF STRONG INTERACTIONS. H. Feshbach and E. L. Lomon (Massachusetts Inst. of Tech., Cambridge). Ann. Phys. (N. Y.), 29: 19-75(Aug. 1964). (TID-20270)

Analytic properties in the complex energy plane of the wave function following from the boundary condition model are considered. Here it is shown that in the finite plane these properties are identical with those which follow from the ordinary potential model. The Wigner condition on the logarithmic derivative F at the boundary condition radius, $dF/dE \leqq 0$, is obtained as a consequence of the requirements of causality, which are taken to apply for a given F for an arbitrary external potential. The Wigner condition implies that an F independent of energy arises in the presence of strong interactions. This is shown to be the case for the many body nonrelativistic system, with the addition of poles to F(E) for compound states present. The Mandelstam relations are assumed and employed in the strip approximation to determine the circumstances under which the boundary condition model would be most appropriate and serve as a good first approximation in an iterative procedure in which crossing symmetry is applied to eliminate model parameters. The relevant Landau-Cutkosky diagrams are determined together with the associated boundary condition radius. The conditions are obtained such that at the specified radius one may expect approximate energy independence of F, except for poles in F(E) due to intermediate single particle states, analogous to the effect of compound states in nonrelativistic theory. The characteristic dependence on energy of the phase shifts as generated by a boundary condition model is described. The results of the application of the model to elementary particle interactions, (NN), (πN), ($\pi\pi$), (KN), and ($\bar{K}$N) are summarized; and the general results obtained are elaborated and extended. Use is made of crossing symmetry and of coupled channels. The energy dependence of the S-matrices for these interactions is found to be of the boundary condition model form with the conclusion that the model will furnish a good first description of these interactions. (auth)

37891 THE PHYSICS OF ELEMENTARY PARTICLES. E. H. S. Burhop (London Univ.). Contemp. Phys., 5: 348-58(June 1964).

A review is given of recent progress in elementary particle physics. A table of the fundamental particles and their excited states is given, and the methods of producing and detecting isobars, the relation between isobars and high-energy elastic scattering, the relative parities of strange particles, a double hyperfragment, weak interactions and neutrino physics, and high energy interactions of cosmic radiation are discussed. Developments in accelerators that will aid future work in particle physics are considered. (C.E.S.)

37892 GENERAL CALCULATIONS OF MATRIX ELEMENTS FOR POLARIZED VECTOR PARTICLES. A. A. Bogush and A. I. Bolsun (Inst. of Physics, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 155: 1046-9 (Apr. 11, 1964). (In Russian)

Compact matrix expressions for 10-dimensional wave functions describing the state of a vector meson ($m \neq 0$) with given 4-momentum magnitude $p = (\mathbf{p}, ip_0)$ and spin projections ± 1 were found previously, using the method of projected operators and the theory of elementary particles. On the basis of the obtained data a covariant method was developed for direct calculations of matrix elements of longitudinally polarized particles with spin 1. The method was normalized for the case of a vector particle with arbitrary spin, and general calculations were made. Calculations of differential cross sections for polarized vector meson scattering on scalar particles and Coulomb centers were used as a comprehensive example. (R.V.J.)

37893 GAUGE INVARIANCE AS A CONSEQUENCE OF GALILEI-INVARIANCE FOR ELEMENTARY PARTICLES. J. M. Jauch (Université, Geneva and CERN, Geneva). Helv. Phys. Acta, 37: 284-92(1964).

If a distinction is made between kinematical and dynamical symmetries of a quantum mechanical localizable system it is possible to extend the principle of Galilei-invariance to elementary particles, subject to arbitrary external forces. This principle implies a severe restriction on the possible types of external forces which can act on a particle. It is shown that for a scalar particle the only forces that are compatible with this principle are those that derive from a scalar and vectorpotential. The hamiltonian takes on the usual gauge-invariant form of a charged particle in interaction with arbitrary electromagnetic forces. (auth)

37894 NOTE ON THE RELATIVISTIC WAVE EQUATION OF A PARTICLE HAVING A SPIN OF $\frac{1}{2}$. C. M. Srivastava (Indian Inst. of Tech., Bombay). Indian J. Pure Appl. Phys., 2: 264-5(Aug. 1964).

The Klein-Gordon equation was linearized in a slightly different way than the one used by Dirac. The modified Dirac equation was shown to be invariant under Lorentz and CPT transformations. Free particle solution of the equation was obtained. (auth)

37895 CONSEQUENCES OF DILATION GROUPS AT VERY HIGH ENERGIES. H. A. Kastrup (Universität, Munich). Nucl. Phys., 58: 561-79(Sept. 1964). (In German)

The hypothesis that the dilatations in space and time become important at very high energies is analyzed. Since the homogeneous functions form irreducible representations of the dilatations, the elastic scattering amplitude F(s,t) is assumed to become homogeneous at very high energies in those variables, which are large compared to the rest masses of the particles concerned (s and t are the squared total energy and the squared momentum transfer in the center-of-mass system). This means that for the forward direction $F(s,t) \sim \beta(t)s^{\alpha(t)}$ if $s \to \infty$, and for large s and t one has $F(s,t) \sim F_{00}(s/t)$ or $d\sigma_{el} \sim (\text{const}/s)d\Omega$ for the elastic differential cross section at fixed scattering angle $\neq 0$. These results are extended to the case of 2 initial particles being scattered into n final ones. If some of the particles have the same directions, a generalized Regge behavior is obtained; if all directions are different, the inelastic amplitude $F(2 \to n)$ behaves like $(\sqrt{s})^{2-n}$ for $s \to \infty$. For the partial wave amplitude $F_l(s)$ it follows that $F_l \sim \text{const} \neq 0$ if $s \to \infty$. This limit is compatible with unitarity. (auth)

37896 UNITARITY, HERMITICITY, AND DISCONTINUITY RELATIONS. John R. Taylor (Cambridge Univ., Eng.). Nucl. Phys., 58: 580-92(Sept. 1964).

The relation between unitarity, Hermitian-analyticity and the discontinuity relations for the T matrix is discussed. The generalized discontinuity relations (generalized unitarity) are examined, and their theoretical status is discussed. It is shown that symmetry of the T matrix has no relevance to these properties. Finally, all these properties are proved in the framework of the multichannel Schrödinger theory. It is shown that in Schrödinger theory the discontinuity relations arise naturally from the definition of the S matrix in terms of ingoing and outgoing waves and that unitarity and Hermitian analyticity hold when the potential matrix is Hermitian. (auth)

37897 REGGE-KHURI REPRESENTATION FOR PHOTOPRODUCTION. Y. S. Jin (Inst. for Advanced Study, Princeton, N. J.) and H. A. Rashid. Nucl. Phys., 58: 611-24(Sept. 1964).

The Gribov-Froissart continuations of various multipole amplitudes of the pion photoproduction process into the complex J-plane are introduced. Assuming the meromorphy of these interpolated multipole amplitudes in the complex J-plane, the Regge-Khuri representation for the pion photoproduction is obtained. The contribution of the nucleon Regge pole to the low-energy M_{1-} amplitude is briefly discussed. (auth)

37898 THE NEUTRON DEUTERON DOUBLET SCATTERING WITH TENSOR FORCES. V. S. Bhasin (Univ. of Delhi). Nucl. Phys., 58: 636-40(Sept. 1964).

The radial equations for the scattering amplitude of the n-d system corresponding to the quantum numbers $J = \frac{1}{2}$ and $T = \frac{1}{2}$ are set up, using the Yamaguchi potential including tensor forces. (auth)

37899 THE COLLECTIVE VIBRATIONS OF A MANY-FERMION SYSTEM. B. Jancovici and D. H. Schiff (Faculte des Sciences, Orsay, France). Nucl. Phys., 58: 678-86 (Sept. 1964).

The energy levels of a many-fermion system are investigated through an extension of the generator coordinate method of Peierls-Yoccoz and Wheeler-Griffin. A trial wave function Ψ for the system is taken as a superposition $\Psi = \int F(z)\Phi(z)dz$ of all possible independent particle wave functions Φ in the neighborhood of the Hartree-Fock ground-state wave function Φ_0. The functions Φ depend on many parameters z. An integral equation is established for the generator function F(z). Through appropriate approximations, this integral equation is transformed into the Schrödinger equation for a set of coupled harmonic oscillators, which can be solved. The energies and wave functions are obtained for the ground state and the low excited states of the system. The present approach is equivalent to the random phase approximation. (auth)

37900 THE INTERNAL SYMMETRIES OF ELEMENTARY PARTICLES. J. A. de Vos (Universiteit, Amsterdam). Nucl. Phys., 59: 65-80(Oct. 1964).

It is suggested that the internal symmetry groups may be considered as so-called neutral subgroups of SO(8) with respect to its three lowest dimensional vector and spinor representations. The mathematical problem implied was solved under certain restrictions. Nearly all the symmetry groups previously proposed reappear in definite representations with definite reductions and with certain relations between them. The simultaneous quantum numbers charge and hypercharge are contained in every one as a consequence of this approach. (auth)

37901 ELECTRON-ELECTRON SCATTERING WITH BREMSSTRAHLUNG CORRECTIONS. Till B. Anders (Universität, Freiburg i. B.). Nucl. Phys., 59: 127-40(Oct. 1964).

The cross section for electron-electron scattering with emission of an arbitrary photon was given on the basis of quantum electrodynamics to the order α^3 without recourse to any further approximations. In view of the class of electron-electron scattering experiments in which one of the scattered electrons is analyzed, the cross section was integrated over the available phase space of the photon variables. This also was done exactly by analytical integration over the photon angles and by numerical integration over the angular uncertainty permitted by the experimental arrangement. In this way, the inelastic radiative correction was obtained as a function of the relative opening angle of the scattered beam without any restrictions on the size of the opening. The calculation includes also an exact evaluation of the contribution coming from high-energy photons. Comparison with earlier approximations shows that the influence of high energy photons was underestimated considerably for increasing opening. The results are tabulated for input energies of 11, 20.57, 500, 1000, 10000 and 100000 mc^2 in the laboratory system. When taken together with the contribution of the elastic radiative correction, satisfactory agreement was obtained with the measurements carried out by Dally with a 500-Mev electron beam. (auth)

37902 NUCLEON-NUCLEON PHASE SHIFTS NEAR 50 Mev. C. J. Batty (National Inst. for Research in Nuclear Science, Chilton, Berks, Eng.) and J. K. Perring. Nucl. Phys., 59: 141-4(Oct. 1964).

A phase-shift analysis was made of p-p and n-p scattering experiments at energies near 50 Mev. It was found that the recent triple scattering experiments considerably improve the accuracy with which the $^3P_0$ phase-shift can be determined. (auth)

37903 POSSIBLE PROTON-ALPHA SCATTERING EXPERIMENTS AT 40 Mev. C. C. Giamati (Lewis Research Center, Cleveland) and R. M. Thaler. Nucl. Phys., 59: 159-67(Oct. 1964).

Two classes of experiments — measurement of the triple scattering parameters and measurement of the polarization in the region of the Coulomb interference scattering cross section minimum — were examined. It was concluded that a measurement of the polarization near the Coulomb interference minimum would serve to establish on a purely ex-

perimental basis the complete scattering amplitude in the forward direction. This information would remove the ambiguity in the phase-shift analysis of the data. (auth)

37904 DISPERSION RELATION FOR COMPTON SCATTERING ON A PROTON. L. V. Filkov and N. F. Nelipa (Lebedev Inst. of Physics, Moscow). Nucl. Phys., 59: 225-34(Oct. 1964).

One-dimensional dispersion relations with one subtraction are obtained at a fixed recoil momentum from double dispersion relations. The results are applied to the analysis of experimental data. (auth)

37905 ON THE MACROSCOPIC PROPERTIES OF A BARYON GAS. PART I. ENERGY AND PRESSURE OF A NEUTRON GAS AT ZERO TEMPERATURE. L. Gratton and G. Szamosi (CNEN-EURATOM, Rome; Università, Rome; and CNR, Rome). Nuovo Cimento (10), 33: 1056-66(Aug. 16, 1964).

The problem of the equation of state of a zero-temperature neutron gas is briefly reviewed. Expressions for the energy and pressure are obtained for densities up to nuclear density by means of a Hartree-Fock method, which is essentially a suitably modified version of Gombas' statistical nuclear model, for higher densities by means of a rather rough model of a relativistic Fermi gas with excluded volumes, thus allowing for the hard core of nucleons. (auth)

37906 NOTE ON HIGH-ENERGY PROTON-PROTON SCATTERING. H. A. Bethe (CERN, Geneva). Nuovo Cimento (10), 33: 1167-72(Aug. 16, 1964).

It was suggested that the elastic scattering of high-energy protons can be considered as the sum of a statistical contribution depending on the total energy, and a diffraction term depending on the four-momentum transfer, f(t). Detailed examination of the Cornell-Brookhaven measurements shows that this is not possible, even under very general assumptions about f(t), but that the diffraction term, for any given t, decreases strongly with increasing energy. (auth)

37907 EXCHANGE CURRENTS AND THE DISINTEGRATION OF THE DEUTERON BY PHOTONS AND ELECTRONS. B. Bosco (Università, Turin), P. P. Delsanto, and F. Erdas. Nuovo Cimento (10), 33: 1240-3(Aug. 16, 1964).

The disintegration of deuterons by electrons and photons is discussed as an experiment to test the existence of nucleon exchange currents at low energy. (C.E.S.)

37908 ENERGY PEAKS FOR THREE-BODY MESON SYSTEMS. S. F. Tuan (Purdue Univ., Lafayette, Ind. and CERN, Geneva). Phys. Letters, 11: 248-50(Aug. 1, 1964).

The energy peaks expected on the basis of a crossed one meson exchange diagram for direct meson-unstable meson systems are discussed. It is shown that in general no resonances will be generated in the coupled channels when the diagram is joined by unitarity to final and/or initial systems involving only stable mesons. Experimental tests of the theory are proposed. (D.C.W.)

37909 PRODUCTION OF NUCLEON ISOBARS WITH $\frac{1}{2}$ SPIN IN NEUTRINO-NUCLEON COLLISIONS. I. M. Zheleznykh (Lebedev Inst. of Physics, Moscow). Phys. Letters, 11: 251-3(Aug. 1, 1964).

The cross section for the interaction $\nu + N \rightarrow \mu^- + N^*$, where $N^* = N + m\pi$, is calculated, assuming that the universal four-fermion interaction may involve fermions with spin $\frac{3}{2}$. The growth of the cross section of single-pion processes with energy in the range of several Bev can be explained by the direct participation of the $\frac{3}{2}$-spin isobars in the four-fermion interaction if the form factors of the processes decrease more slowly with the growth of q^2 than the Hofstadter form factors. (D.C.W.)

37910 AN INVESTIGATION OF THE REACTION $p + p \rightarrow d + \pi^+$ AT AN INCIDENT PROTON ENERGY OF 990 Mev. K. R. Chapman, T. W. Jones, Q. H. Khan, J. S. C. McKee, H. B. Van Der Raay, and Y. Tanimura (Univ. of Birmingham, Eng.). Phys. Letters, 11: 253-4(Aug. 1, 1964).

The differential cross section for the interaction $p + p \rightarrow d + \pi^+$ at 990 Mev was measured at meson(π^+) angles between 24.5 and 90° in the center of mass system. The total cross section (560 ± 30 ub at 990 Mev) is dominated at lower energies by the peak due to the $J = \frac{3}{2}$, $T = \frac{3}{2}$ resonance; but at energies above this resonance, the cross section decreases uniformly. (D.C.W.)

37911 ELEMENTARY PARTICLES AND SU(4). B. J. Bjoerken and S. L. Glashow (Universitet, Copenhagen). Phys. Letters, 11: 255-7(Aug. 1, 1964).

A model is proposed involving four fundamental baryons (an isodoublet and two isosinglets) and assuming that the strong interactions are approximately invariant under 4X4 unitary transformations, exactly invariant under independent phase transformations of each of the four baryons, and invariant under the isotopic group. A formula relating the masses of the nine vector mesons and predicting a ninth pseudoscalar meson at 950 Mev is obtained, together with a description of weak interactions and a baryon-lepton symmetry. A new conserved quantum number violated only by the weak interactions is defined. (D.C.W.)

37912 THE COMBINATION OF LORENTZ AND SU_3 INVARIANCE. C. W. Gardiner (Univ. of Auckland, N. Z.). Phys. Letters, 11: 258-60(Aug. 1, 1964).

The existence of a scheme permitting the simultaneous classification of particles by a symmetry group and the homogeneous Lorentz group is demonstrated for the case of the SU_3 group. (D.C.W.)

37913 TEST FOR THE SPIN OF THE $\pi\rho(1310)$ RESONANCE FROM ITS DECAY ANGULAR DISTRIBUTIONS. E. de Rafael (Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France). Phys. Letters, 11: 260-2 (Aug. 1, 1964).

Relations are given by which the spin of the meson(R) can be obtained from the angular distributions for $R \rightarrow \rho + \pi$ and $R \rightarrow K + \bar{K}$. (D.C.W.)

37914 A STUDY OF THE BETA-DECAY OF $\Sigma^{\pm}$-HYPERONS. D. J. Miller (London Univ.), F. R. Stannard, A. Bezaguet, U. Nguyen-Khac, A. Haatuft, and A. Halsteinslid. Phys. Letters, 11: 262-3(Aug. 1, 1964).

Sixteen beta decays of hyperon (Σ^-) and no beta decays of hyperon (Σ^+) were identified in an exposure of a C_2F_5Cl bubble chamber to 1.47-Bev/c mesons(K^-). The branching ratio $\Sigma^- \rightarrow n + e^- + \bar{\nu}/\Sigma^- \rightarrow n + \pi^-$ was determined to be $1.15 \pm 0.4 \times 10^{-3}$. (D.C.W.)

37915 DIFFRACTION PATTERNS FOR ELASTIC SCATTERING OF ELEMENTARY PARTICLES. A. Dar (Weizmann Inst. of Science, Rehovoth, Israel), M. Kugler, Y. Dothan, and S. Nussinov. Phys. Letters, 11: 265-6 (Aug. 1, 1964).

The differential cross sections for elastic $\pi^{\pm}$-p and K^--p scattering at 2 Bev/c were analyzed by a black sphere model. Numerical results for the elastic and total cross sections were obtained. The model gave the general features of the experimental data. (D.C.W.)

37916 DIRECT EVIDENCE FOR THE VALIDITY OF THE $\Delta I = \frac{1}{2}$ LEPTONIC RULE IN K^0 β DECAY. B. Aubert,

L. Behr, J. P. Lowys, P. Mittner, and C. Pascaud (Ecole Polytechnique, Paris). Phys. Letters, 11: 267-9(Aug. 1, 1964).

The absolute rate of the three-body beta decay of mesons (K_2^0) was measured. The value obtained is in good agreement with the prediction of the $\Delta I = \frac{1}{2}$ rule. (D.C.W.)

37917 THE PREDICTION OF 1^+, 2^-, 2^+ MESON SUPERMULTIPLETS IN THE Gev REGION BY A SELF-CONSISTENT BOOTSTRAP MODEL. Hong-Mo Chan (CERN, Geneva). Phys. Letters, 11: 269-72(Aug. 1, 1964).

Starting from the pseudoscalar (0^-) mesons (π, K, η) and the vector (1^-) resonances (ρ, K*, φ), it was previously found that the bootstrap hypothesis under SU_3 invariance requires, for consistency, the existence of an octet and a singlet of scalar (0^+) particles in addition to the original 0^- and 1^- octets. The consequences of accepting the 0^+ octet as genuine were investigated. A completely self-consistent bootstrap solution was obtained which bootstraps the original 0^- octet, yielding a mass value consistent with the scheme; predicts the existence of a pseudovector 1^+ octet in the Bev region; and excludes the occurrence of 10, $\overline{10}$, and 27 meson supermultiplets at low energies. (D.C.W.)

37918 PHOTODISINTEGRATION OF THE DEUTERON BY POLARIZED PHOTONS. F. F. Liu (Stanford Univ., Calif.). Phys. Letters, 11: 306-7(Aug. 15, 1964).

The asymmetry in the photodisintegration of deuterons by polarized photons between 80 and 140 Mev was measured at 90° in the center of mass system. The results were compared with theoretical predictions. The asymmetry was noted to undergo a reversal in sign between photon energies of 120 and 130 Mev. The data indicate that the magnetic amplitude is larger than that of presently available calculations. (D.C.W.)

37919 A BOOTSTRAP CALCULATION FOR THE MASS OF THE $\pi\pi(T = 0, l = 0)$ ANTIBOUND STATE. S. Ciulli and Gr. Ghika (Inst. for Atomic Physics, Bucharest). Phys. Letters, 11: 336-9(Aug. 15, 1964).

A bootstrap calculation of the mass of the antibound state indicated by the $\pi + \pi \rightarrow \pi + \pi$ scattering near the elastic threshold was performed for scattering lengths for T = 0 ranging from 1 to 2.5. (D.C.W.)

37920 PION-NUCLEON SCATTERING IN THE RANGE 300-700 Mev AND THE POSSIBLE P_{11} RESONANCE. B. H. Bransden (Univ. of Durham, Eng.), P. J. O'Donnell, and R. G. Moorhouse. Phys. Letters, 11: 339-41(Aug. 15, 1964).

The results of an energy-dependent phase shift analysis of π^+-p scattering at 300 to 700 Mev are presented. The results indicate that the p_{11} resonance is around 600 Mev, not 430 Mev, if it exists. (D.C.W.)

37921 COMPARISON OF CABIBBO WEAK CURRENTS WITH EXPERIMENT. N. Brene (Universitet, Copenhagen), B. Hellesen, and M. Roos. Phys. Letters, 11: 344-7 (Aug. 15, 1964).

Branching ratios for leptonic decays were calculated by Cabibbo's theory and compared with experimental values in good agreement. Cabibbo angles in baryon and meson decays were obtained; and the d/f mixing parameter for the weak axial vector current of the baryons was determined to be near the d/f mixing parameter in strong interactions. (D.C.W.)

37922 PION SYSTEMS IN π^+d INTERACTIONS AT 4.5 Gev/c. A. Forino (Università, Bologna), R. Gessaroli, L. Lendinara, et al. Phys. Letters, 11: 347-50(Aug. 15, 1964).

The interaction of mesons (π^+) with deuterons at 4.5 Bev/c was investigated, using a deuterium bubble chamber. A peak in the $\pi^+\pi^-\pi^0$ spectrum at about 1325 Mev was considered in some detail, as was the decay mode of the meson(f^0). (D.C.W.)

37923 COINCIDENCE MEASUREMENT OF ELECTROPRODUCTION OF π^0. J. P. Perez Y Jorba, P. Bounin, and J. Cholliet (Faculté des Sciences, Orsay, France). Phys. Letters, 11: 350-2(Aug. 15, 1964).

The cross section for the interaction $e + p \rightarrow e + p + \pi^0$ was determined by scattering 470-Mev electrons on liquid hydrogen and detecting the scattered electrons and protons in coincidence. (D.C.W.)

37924 $\omega-\varphi$ MIXING AND THE MASS FORMULA FOR PSEUDOSCALAR MESONS IN A NON-PERTURBATIVE MODEL. H. Pietschmann (Universität, Vienna). Phys. Letters, 11: 352-5(Aug. 15, 1964).

Mass formulas for the pseudoscalar mesons are derived, treating $\omega-\varphi$ mixing as the symmetry breaking interaction. For equal bare masses of φ and ω, the Gell-Mann-Okudo mass formula comes out to all orders in the symmetry breaking interaction. (D.C.W.)

37925 A DYNAMICAL MODEL FOR A $J^P = \frac{3}{2}^-$ NONUPLET. J. J. Brehm (Northwestern Univ., Evanston, Ill.) and K. C. Wali. Phys. Letters, 11: 355-7(Aug. 15, 1964).

The possibility of including the 1512-, 1520-, and 1660-Mev baryon-meson resonances in a 9-dimensional representation of W(3) symmetry based on the assumption $J^P = \frac{3}{2}^-$ is considered. (D.C.W.)

37926 BRANCHING RATIO FOR THE MUONIC DECAY MODE OF THE LAMBDA HYPERON. B. Ronne (CERN, Geneva), C. Baglin, J. Six, W. L. Knight, F. R. Stannard, and A. Haatuft. Phys. Letters, 11: 357-60(Aug. 15, 1964).

The branching ratio for the decay mode $\Lambda \rightarrow p + \mu^- + \bar{\nu}$ was determined by analysis of hyperon (Λ) decays observed in exposure of a C_2F_5Cl bubble chamber to 1.45-Bev/c mesons(K^-). (D.C.W.)

37927 ELECTROMAGNETIC STRUCTURE OF THE NUCLEON AND VECTOR MESONS. Hirofumi Hayashi, Rokuo Kawabe, and Isao Umemura (Nagoya Univ., Japan). Progr. Theoret. Phys., (Kyoto), 31: 825-39(May 1964).

A model for nucleon structure is proposed in which the contribution from one more isoscalar vector meson in addition to those of ρ and ω mesons is taken into account. The three-pole formulas for the nucleon form factor based on this model give a better fit for the experimental data than the two-pole formulas with only ρ and ω mesons, suggesting the existence of another isoscalar particle interacting strongly with the nucleon. It might be identified with the meson(φ). The electromagnetic radii of nucleons are calculated from the best fitting parameters to nucleon form factors. The charge clouds of the proton and the neutron indicate characteristic spatial behaviors in this model. The relations among various renormalized coupling constants of the vector mesons to the nucleon are also numerically discussed. (auth)

37928 LINKED HEAVY PARTICLE MODEL AND MULTIPLE PARTICLE PRODUCTION. Tetsuro Kobayashi, Mikio Namiki, and Ichiro Ohba (Waseda Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 31: 840-57(May 1964).

It is shown that the multiperipheral model with meson(π) bridges proposed by Amati may be inconsistent with the experimental data on cosmic-ray jets. A linked heavy particle model is presented to interpret various features of multiple particle productions at very high energies. The multiplicity and the other important parameters of multiple particle production are obtained through the semi-kinemati-

cal calculations, under the assumption that the invariant four momentum transfer squared is constant for any part of the links. The fluctuations of the multiplicity and the forward-backward asymmetry of produced particles are discussed. (auth)

37929 MASS SPLITTINGS OF THE STRONGLY INTERACTING PARTICLES. Keiji Kikkawa (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 31: 858-78(May 1964).

According to the idea of spontaneous breakdown of the symmetry, mass relations among the distinct multiplets of a group are studied. An interacting system which possesses the symmetry SU(3) (unimodular unitary group) is first considered. Introducing the mass counter terms with the broken symmetry, self-consistent solutions to the vertex function of the gravitational field (masses of the particles) are obtained. It is assumed that the mass splitting among particles which belong to a common unitary-multiplet satisfy the Gell-Mann-Okubo mass formula. Ratios among the parameters which are contained in the Gell-Mann-Okubo formula (asymmetry parameters of the meson and baryon masses) are determined by the existence condition of the asymmetry solutions to the mass equation. As a natural consequence of the spontaneous breakdown the characteristic magnitude of the mass splitting for the pseudoscalar mesons (π, η, K and $\overline{K}$) is about (m/μ) times that for the baryons (Σ, Λ, N and Ξ). Correct signs of the mass asymmetry parameters are also predicted by the choice of the F-D mixing ration $\xi \equiv F/D \sim 0.7$. The magnitude of the meson mass splitting is a little large in this approximation. (auth)

37930 STRONG COUPLING MESON THEORY AND ITS IMPLICATIONS FOR THE SPECTRUM AND STRUCTURE OF NUCLEONS. Masami Wakano (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 31: 879-915(May 1964).

The π-N resonance states and the charge form factors of the proton and the neutron were analyzed, using the Pauli-Dancoff method of the strong coupling meson theory. The work by Pais and Serber on the Pauli-Dancoff representation was completed by tracing the isomorphic variation domains of the new variables. It was shown by comparison with the Neumann theory of observation that the collective motions fo the meson cloud in ordinary and charge spaces can be correlated with each other. The Schrödinger equations for the correlation coefficient are solved which determine the energy levels of excited states of the physical nucleon. The strong-coupling meson theory is compared with the Chew-Low static theory. (auth)

37931 CONSTRUCTION OF THE JOST FUNCTION INCLUDING INELASTIC PROCESSES. Takesi Ogimoto (Osaka Univ.). Progr. Theoret. Phys. (Kyoto), 31: 916-23 (May 1964).

By using Warnock's theorem the Castillejo-Dalitz-Dyson (CDD) ambiguity appearing in the N/D method is separated for the case in which inelastic processes are present. The D function is continued into the second Riemann sheet of the center-of-mass momentum squared; the Jost function including inelastic processes and the CDD poles is obtained uniquely. (auth)

37932 RESONANCE FAMILIES AND ADDITIVITY RULE. [PART] I. Takehiko Takabayasi (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 31: 923-5(May 1964).

A model for resonances, particularly the p-wave states, is proposed in which the resonances are attributed to two-body configurations of basic particles (baryons and ps-mesons). The resonance energy is attributed to additive contributions of the resonance energy due to each constituent particle. (D.C.W.)

37933 RESONANCE FAMILIES AND ADDITIVITY RULE. [PART] II. Takehiko Takabayasi (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 31: 925-6(May 1964).

The model of the preceding article is extended to d- and s-wave states to show that it may provide a uniform systemization of the known mesonic resonances and lower baryonic excitations. (D.C.W.)

37934 $\omega-\varphi$ MIXING AND COUPLING CONSTANTS. Masataka Hosoda (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 31: 926-8(May 1964).

The coupling constants and mixing parameters in the coupling of vector mesons to baryons are investigated within the framework of unitary symmetry. (D.C.W.)

37935 ON TWO FORMULATIONS OF COMPOSITE PARTICLES IN THE S-MATRIX THEORY. Masayuki Uehara (Univ. of Osaka Prefecture, Sakai, Japan). Progr. Theoret. Phys. (Kyoto), 31: 928-9(May 1964).

The one- and two-body approaches to composite particles are shown to give generally nonidentical coupling constant-mass ratio relations. (D.C.W.)

37936 REMARKS ON BROKEN G_2 SYMMETRY. Mahiko Suzuki (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 31: 930-1(May 1964).

It is shown that the broken G_2 symmetry scheme contradicts the concept of spontaneous breakdown or self-consistent deviation. (D.C.W.)

37937 SPIRALITY INVERSION AND THE UNIQUENESS OF PHASE SHIFTS IN NUCLEON-NUCLEON SCATTERING. Masaaki Kawaguchi, Tamotsu Ueda, and Wataro Watari (Australian National Univ., Canberra and Osaka Univ.). Progr. Theoret. Phys. (Kyoto), 31: 933-5(May 1964).

Inversion of the projection of the polarization of the particle along the direction of its velocity is investigated, particularly the Klepikov-Smorodinskii ambiguity. The Hamada-Johnson phase shifts are shown to uniquely represent the N-N scattering in both isosinglet and isotriplet states. (D.C.W.)

37938 TRIPLET AND OCTET MIXING. Masataka Hosoda (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 31: 935-7(May 1964).

The decay rates of the physical meson($\overline{\varphi}$) into K + $\overline{K}$ and of the physical meson($\overline{K}^*$) and meson(κ) into K-π systems were calculated, assuming that the meson(κ) is 1^- and belongs to the triplet of the SU(3) group together with the meson(ω). The coupling between the $|3\rangle$ (triplet) and $|8\rangle$ is relatively large; and the physical states $|\overline{\varphi}\rangle$, $|\overline{\omega}\rangle$, $|\overline{K}^*\rangle$ and $|\overline{\kappa}\rangle$ are mixtures of bare states $|8\rangle$ and $|3\rangle$. (D.C.W.)

37939 UNIFORMITY OF SQUARED-MASS FORMULAS FOR STRONGLY INTERACTING PARTICLES. Takehiko Takabayasi (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 31: 937-8(May 1964).

Mass formulas are presented which represent squared masses by simple and uniform expressions linear with respect to the internal quantum numbers (isospin and strangeness) for the case of baryons as well as mesons. (D.C.W.)

37940 EMPIRICAL FORMULAS OF ELECTROMAGNETIC MASS DIFFERENCE AND BARYON MAGNETIC MOMENT. Hiroshi Katsumori (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 31: 938-40(May 1964).

It is shown that the relation obtained in the unitary symmetry scheme for the electromagnetic mass shifts of the

baryons can be obtained without regard to any special type of symmetry model. Empirical formulas for the mass shifts of the baryons and meson and for the baryon magnetic moments are given. (D.C.W.)

37941 NOTE AGAINST THE SELF-CONSISTENT DERIVATION OF THE $|\Delta I| = 1/2$ RULE. Keiji Kikkawa (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 31: 942-3 (May 1964).

A difficulty in the self-consistent approach with the spontaneous breakdown for the case of weak interaction is outlined. (D.C.W.)

37942 THE SCATTERING OF PARTICLES IN AN INFINITE PLANE SLAB. P. J. Brockwell (Australian National Univ., Canberra). Nuovo Cimento (10), 33: 1091-1107(Aug. 16, 1964).

A three-dimensional scattering process is studied using the theory of discontinuous Markov processes, extending results previously obtained in one dimension by Brockwell and Moyal. The scattered particles are assumed to move in one of a set of thirty directions in space. Constant mean free path is assumed, scattering is axially symmetric, and velocity transition probabilities $\psi_\theta(dv|u)$ are defined for each collision depending on the angular deflection. It is shown how the results obtained for the discrete set of directions can be used to approximate the physically more realistic continuous case; a numerical comparison with exact results is given for the well-known Milne problem with isotropic scattering. For a steady stream of particles incident on one face of a slab $\{x: a \le x \le b\}$ it is shown how to determine the time-independent solution for the mean number of particles per second crossing a plane $x = \xi$ in any given direction. The distribution of velocity and direction with which particles emerge from a slab is also determined assuming the probabilities $\psi_\theta(dv|u)$ satisfy a certain commutativity condition. If there is a constant (nonzero) probability of absorption at a collision no essential modification of the analysis is required. (auth)

37943 RADIATIVE CORRECTIONS TO $\pi \to \mu$ (OR e) + ν WITH FINITE NEUTRINO MASS. A. N. Kamal (Univ. of Alberta, Edmonton, Can.). Nuovo Cimento (10), 33: 1108-18 (Aug. 16, 1964).

The radiative corrections to the decay $\pi \to$ lepton + ν were calculated to order e^2 in the coupling constant and to order m_ν^2 in the neutrino mass. The possibility of setting upper limits on the neutrino mass by measuring the photon spectrum in the radiative decay of pion is investigated. The effect of the neutrino mass on the branching ratio $(\pi \to e)/(\pi \to \mu)$ is found to be small enough to elude experimental detection with the present experimental accuracies. (auth)

37944 DISPERSION RELATIONS FOR ANALYTICALLY CONTINUED PARTIAL-WAVE AMPLITUDES IN POTENTIAL THEORY. A. R. Swift (Univ. of Pennsylvania, Philadelphia). Nuovo Cimento (10), 33: 1119-37(Aug. 16, 1964).

The dispersion relations of Fivel are extended to physically meaningful situations. On the basis of the Mandelstam representation and a modified form of the partial-wave expansion a closed system of equations is obtained for the partial-wave amplitude for values of the angular momentum defined by real λ equal to a constant positive number. A solution by iteration is indicated. The assumption is made that the partial-wave amplitude has a rightmost singularity in the complex angular momentum plane. The methods are extended to provide a new derivation of the integral equation satisfied by the Mandelstam spectral function. (auth)

37945 ANGULAR CORRELATIONS BETWEEN FINAL STATE PARTICLES IN K^--p COLLISIONS AT K^- MOMENTUM 1150 Mev/c. V. P. Gautam and B. K. Agarwal (Allahabad Univ., India). Nuovo Cimento (10), 33: 1136-44 (Aug. 16, 1964).

The isobar model is applied to study angular correlations of final-state particles in the reaction $K^- + p \to \Lambda + \pi^+ + \pi^-$ at K^- momentum 1150 Mev/c. It is found that the calculated results are in reasonable agreement with the experimental data available and are an improvement over the phase-space results. (auth)

37946 EQUIVALENCE AMONG FERMION SYMMETRY-MULTIPLETS AND CHOICE OF THE SYMMETRY GROUP FOR STRONG INTERACTIONS. A. Simoni (Università, Naples) and B. Vitale. Nuovo Cimento (10), 33: 1199-1213 (Aug. 16, 1964).

The definition of an equivalence principle among all symmetry multiplets is discussed from the point of view of its relevance on the possible choice of the correct symmetry group under which the strong interactions are invariant. The problem, already discussed by Moravcsik and Gerstein, is formulated; the limitations introduced by the very existence of a minimal set of fundamental fields are made explicit; the consequences of the assumption of a Yukawa coupling among fermion and boson fields are analyzed; a general formula giving the reduction of the direct product of two irreducible representations for the unitary group is derived and used to demonstrate an existence theorem; the assumption of a Yukawa coupling is dropped, and the problem of the consistency of a multiplet assignment with the principle of equivalence is discussed in general, by introducing and defining the different types of irreducible representations for all Lie groups of rank two; in particular, the trinity type discussed recently by Biedenharn and Fowler is introduced for SU_3 by a procedure which is applicable to all groups and which leads to analogous duality types for the irreducible representations of C_2 and B_2; it is further shown that only one type is present among the irreducible representations of G_2. A larger definition of a principle of equivalence is proposed, to be satisfied by all symmetry groups and by any realistic dynamical model for strong interactions. (auth)

37947 DYNAMICS OF PION RESONANCES THROUGH "REPULSIVE" POTENTIALS. A. N. Mitra (Univ. of Delhi). Nuovo Cimento (10), 33: 1220-4(Aug. 16, 1964).

A suitable dynamic scheme of p-wave π-π interactions which could lead to some understanding of the features of ρ and φ within the premises of phenomenological strong interactions without involving new physical ideas. A potential with a repulsive kernel and a Shiff-type semi-relativistic approximation for the 2-π and 3-π kinetic energies was used. (C.E.S.)

37948 A BOOTSTRAP CALCULATION FOR RESONANCES IN THE $\overline{K}\Lambda$ SYSTEM. I. M. Bar-Nir (Tevl-Aviv Univ., Israel and Israel Atomic Energy Commission, Yavneh). Nuovo Cimento (10), 33: 1236-9(Aug. 16, 1964).

The masses of the Y_0^* (1385) and Y_1^* (1815) resonances, which are regarded as intermediate states of the $\overline{K}N$ system, are calculated by means of the bootstrap technique. (C.E.S.)

37949 INTERNAL HYDROGEN TARGETS FOR HEAVY LIQUID BUBBLE CHAMBER. L. Carlino (École Polytechnique, Paris), P. Musset, P. Quéru, R. Duthil, J. M. Garin, and M. Marquet. Rev. Sci. Instr., 35: 1274-7(Oct. 1964).

Insertion of a liquid hydrogen target into a heavy liquid bubble chamber combines some of the advantages of the hydrogen bubble chamber (production on free proton) with that of the heavy liquid bubble chamber (detection and measurement of neutral particles). Two different targets

adapted to experiments with 8 and 16-Bev/cπ^- are described. They were used successfully for two experimental runs, which provided 350,000 photographs, in the 1-m bubble chamber. (auth)

37950 REGGE POLES FOR Z^{-4} REPULSIVE POTENTIAL. Yuan-ben Dai. Sci. Sinica (Peking), 13: 1319-22 (Aug. 1964).

The S-matrix element $s(\lambda,k)$ was investigated for a Z^{-4} repulsive potential, and it was found that $s(\lambda,k)$ has infinitely many poles in a small angle neighborhood of the imaginary axis. (C.E.S.)

37951 RADIATIVE CORRECTIONS FOR WEAK INTERACTION PROCESSES. Cheng-jui Ching (Peking Univ.). Sci. Sinica (Peking), 13: 1323-5(Aug. 1964). (In Russian)

Radiative corrections for photons and neutrinos in meson(μ) and neutron decay are discussed. (C.E.S.)

37952 THE CONTRIBUTION OF THE CROSS-DIAGRAM IN THE p-WAVE RESONANCE OF LOW-ENERGY MESON-NUCLEON (π-N) SCATTERING. Nay-i Chu (Peking Univ.). Wu Li Hsueh Pao, 20: 411-17(May 1964). (In Chinese)

It is assumed that the left-cut of π-N scattering can be better approximated by four effective poles than by only one or two poles in the usual way. A calculation was made for the contribution due to the short range interactions of the cross diagram. The resulting phase shift agrees with experiment, and indicates that the low-energy p-wave 3-3 resonance exists. Furthermore, from the calculated results, it can be seen that, to make better approximation, at least four poles must be taken, therefore the behavior of the amplitude of the left-cut is very complicated. (auth)

37953 A NOTE ON THE RADIATIVE DECAY BY ρ MESON. Whi-ning Yang, Sze-wan Hu, and Pey Wang. Wu Li Hsueh Pao, 20: 475-6(May 1964). (In Chinese)

37954 EFFECT OF π-π INTERACTION ON π^+-MESON PHOTOPRODUCTION. Pao-ru Tzu, Chen-hua Yang, and Hong-an Peng (Peking Univ.). Wu Li Hsueh Pao, 20: 501-11(June 1964). (In Chinese)

The process of π^+ photoproduction from protons is considered starting from the Mandelstam representation and using further the Cini-Fubini approximation. The formulas for the isoscalar part of π photoproduction amplitudes are derived. According to new data on electromagnetic structure of nucleons, the parameters of I = J = 1 resonance of π-π interaction are chosen to be $t_r = 22$, $a_v = 1.52$, $b_v = 1.60$, and $d\delta/d\Omega$ (90°), $d\delta_{||}/d\delta_{\perp}$ (90°), and angular distributions are calculated at three energies. The results show that after introducing the π-π interaction the fit to the experiment is much improved over the results obtained by Chew et al. The coupling constant of $\gamma + \pi \rightarrow \pi + \pi$ is determined to be about $\Lambda \approx -2.8$ e, which is roughly consistent with the current results. (auth)

37955 THE SCATTERING OF POSITIVE K-MESONS BY DEUTERONS AND THE LOW ENERGY K-NUCLEON INTERACTION. Victor John Stenger. Thesis, Los Angeles, Univ. of California, 1964. 175p.

The K-nucleon interaction in the isospin T = 0 state and in the momentum region below 800 Mev/c was studied by scattering K^+ mesons on deuterons in the 15-inch bubble chamber of the Lawrence Radiation Laboratory. The experimental data in K^+-deuteron experiments below the threshold for pion production involve the reactions $K^+ + d \rightarrow K^+ + d$, $K^+ + d \rightarrow K^+ + p + n$, and $K^+ + d \rightarrow K^\circ + p + p$. The data were analyzed to obtain the scattering parameters for the two-body K-nucleon interaction in the T = 0 state. The T = 1 state is assumed to be known from K-hydrogen experiments. In the region above one fermi^{-1}, the T = 0 interaction is found to contain significant phase shifts with angular momenta greater than the S-wave. In this region the P-wave appears to dominate, the S-wave is small and attractive, the D-wave is small and repulsive. There are two sets of solutions, which correspond to the Fermi-Yang ambiguity, for the P- and D-wave phase shifts. In one of these the phase shift corresponding to the state of total angular momentum $j = \frac{1}{2}$ is repulsive, the $j = \frac{3}{2}$ is attractive, both being about the same order of magnitude and increasing with energy. In the other solution the $j = \frac{3}{2}$ is consistent with zero and the $j = \frac{1}{2}$ is large and attractive. Below one fermi^{-1} center-of-mass momentum the higher angular momenta appear to be suppressed by a centrifugal barrier indicating that the range of the interaction is of the order of one fermi. In this region the T = 0 interaction is very small, the S-wave scattering length being measured to be -0.04 ± 0.04 fermi, slightly attractive but consistent with zero. In no way does the T = 0 interaction resemble the T = 1 interaction over the energy range studied. (Dissertation Abstr., 24: No. 12, Pt. I (June 1964))

37956 CĚRENKOV LIGHT PRODUCTION IN A WATER MODERATED NUCLEAR REACTOR. Robert William Madey. Thesis, College Park, Md., Univ. of Maryland, 1963. 129p.

An experimental investigation of the production of Cherenkov radiation in a water-moderated nuclear reactor is conducted using a photomultiplier as a light sensor. The variations in light intensity are studied during various phases of reactor operation, namely: startup, steady state, and shutdown. The relevant theory is presented as an aid in interpreting and extrapolating the experimental results. It is found that for transients such as startup, the light signal is directly related to reactor power for periods faster than about 20 seconds. The proportionality between reactor power and Cherenkov signal is no longer valid for whole core measurements made at steady state power level because of the gradual increase of the Cherenkov signal as a result mainly of fission product contributions. Selective scanning of the Cherenkov spectrum through the use of interference filters over the wavelength range 3500 to 5530 Å results in a lower buildup fraction. Indications are that measurements further into the short wavelength region may yield a light sensor, and hence a good power detector, independent of any fission product buildup. The decrease in the Cherenkov light intensity after shutdown is measured for reactor operating times from 20 minutes to 4 hours. Comparison of the empirical data with theoretical considerations results in good agreement for shutdown times ranging from 500 to 10,000 seconds. Spectral measurements made through 17 feet of water with a Hilger quartz spectrograph show a spectral distribution ranging from 2500 to 6000 Å. A calculated spectral distribution is compared with the measured spectrum after correcting for water attenuation. (Dissertation Abstr., 24: No. 12, Pt. I (June 1964))

37957 DISPERSION THEORY METHODS FOR PION-DEUTERON ELASTIC SCATTERING. John Joseph Brehm, Jr. Thesis, College Park, Md., Univ. of Maryland, 1963. 180p.

The problem of low-energy pion-deuteron elastic scattering is undertaken using the methods of dispersion theory. Complex singularities do not occur if the momentum transfer is used as the variable in a dispersion relation with the energy taken to be fixed and real. Anomalous discontinuities are developed by analytic continuation in the deuteron mass. Subsequent analytic continuation in the energy provides the representation of the physical amplitude. A sample calculation is made, ignoring spin. The

contributions of pion-nucleon scattering are estimated by assuming the dominance of the T = 3/2 resonance in the energy channel and of the ABC resonance in the momentum transfer channel. The angular distribution is computed at 85 Mev and some agreement with experimental data is obtained. (Dissertation Abstr., 24: No. 12, Pt. I (June 1964))

37958 NUCLEON STRUCTURE. Proceedings of the International Conference at Stanford University, June 24-27, 1963. Robert Hofstadter and Leonard I. Schiff, eds. Stanford, Calif., Stanford University Press, 1964. 428p. $12.50.

Separate abstracts were prepared for 37 of the 68 papers included. 31 papers were previously abstracted in NSA (17: 9253, 9263, 24340, 26341, 28160, 29505, 32905, 32918, 34819, 34820, 34821, 34822, 34827, 34959, 36569, 36570, 37959, 41308, 41736, 41843; 18: 916, 2584, 4470, 5985, 6243, 9179, 9211, 9422, 10843, 14954, and 15317). (D.C.W.)

For abstracts of individual papers see: 37553, 37554, 37828, 37829, 37864, 37959, 37960, 37961, 37962, 37963, 37964, 37965, 37966, 37967, 37968, 37969, 37970, 37971, 37972, 37973, 37974, 37975, 37976, 37977, 37978, 37979, 37980, 37981, 37982, 37983, 37984, 37985, 37986, 37987, 38181, 38182, and 38183.

37959 THEORY OF NUCLEON FORM FACTORS. David Y. Wong (Univ. of California, San Diego). p.20-7 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

The contributions to the isoscalar and isovector form factors are briefly discussed, together with representations for the form factors. (D.C.W.)

37960 THE MEASUREMENT OF NUCLEON FORM FACTORS WITH THE LINEAR ACCELERATOR OF ORSAY. B. Dudelzak, B. Grossetête, and P. Lehmann (Ecole Normale Superieure, Orsay, France). p.76-84 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

The proton form factors for $q^2 < 4F^{-2}$ were determined by measuring the cross section for elastic electron–proton scattering. The charge form factor of the neutron was obtained from measurements of the cross section for elastic electron–deuteron scattering. (D.C.W.)

37961 POSITRON-PROTON SCATTERING. A. Browman and J. Pine (Stanford Univ., Calif.). p.85-90 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

The difference between electron and positron elastic scattering by protons was investigated by measuring the cross section ratio $\sigma^- - \sigma^+/\sigma^- + \sigma^+$ at five q^2 values from 7 to 19.5 F^{-2}. (D.C.W.)

37962 FIELD THEORY AND REGGE POLES. F. E. Low (Massachusetts Inst. of Tech., Cambridge). p.99-104 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

It is shown that the passage of a trajectory through a particle does not necessarily imply that the particle is not elementary. In quantum electrodynamics, the electron can, in the sense of Feynman perturbation theory, generate a trajectory and lie on it. (D.C.W.)

37963 RECENT ELASTIC-SCATTERING AND POLARIZATION STUDIES OF THE π-N INTERACTION IN THE HIGHER RESONANCE REGION. Robert J. Cence (Univ. of California, Berkeley). p.131-41 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

The resonances (peaks) at 600 and 900 Mev in the π^--p total cross section and at 1350 Mev in the π^+-p total cross section were studied by measuring the $\pi^\pm$-p differential cross sections and the recoil proton polarization at energies near the resonances. Phase-shift analyses of the data were performed. The data are consistent with a $D_{3/2}$, T = 1/2; $F_{5/2}$, T = 1/2; and $F_{7/2}$, T = 3/2 resonances at 600, 900, and 1311 Mev, respectively. (D.C.W.)

37964 THE SYMMETRY PROPERTIES OF π-π INTERACTION IN π-N SCATTERING. P. S. Isaev, V. I. Lend'el, and V. A. Meshcheriakov (Joint Inst. for Nuclear Research, Dubna, USSR). p.145-7 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

Relations for the partial amplitudes for π-N scattering and for the π-π contributions to π-N scattering were derived in the static approximation, starting from the crossing-symmetry properties of the scalar functions $A^\pm$ (s, $\bar{s}$, t) and $B^\pm$ (s, $\bar{s}$, t). The π-π contribution to π-N interactions was investigated. (D.C.W.)

37965 SYSTEMATICS OF MESON SYSTEMS. Donald H. Miller (Univ. of California, Berkeley). p.164-71 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

The development of meson systematics is briefly reviewed, together with associated experimental observations. (D.C.W.)

37966 NUCLEON-NUCLEON INTERACTIONS AND NUCLEON STRUCTURE. G. Breit (Yale Univ., New Haven). p.188-205 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

Theory for N-N interactions is reviewed, with emphasis on the meson effects. 56 references. (D.C.W.)

37967 DATA ON NUCLEON STRUCTURE OBTAINED FROM EXPERIMENTS ON ELASTIC PROTON-PROTON SCATTERING IN THE 5- TO 10-Gev ENERGY REGION. V. G. Grishin (Joint Inst. for Nuclear Research, Dubna, USSR). p.206-11 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

The differential cross sections for elastic p-p scattering at 6 and 10 Bev were measured at very small scattering angles. The data were analyzed in the quasi-classical approximation by the method of least squares. The results indicate a large real part in the spinless term of the scattering amplitude with a strong angular dependence and also rule out the essential contribution to the cross section from the spin terms. (D.C.W.)

37968 RADIATIVE CORRECTIONS TO ELECTRON SCATTERING. Yung-su Tsai (Stanford Univ., Calif.). p.221-7 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

The radiative corrections for an arbitrary one-photon exchange process are calculated, assuming that the target particle is not polarized and that its final products are not detected. (D.C.W.)

37969 THE MUON AS A PROBE FOR NUCLEON STRUCTURE. F. J. M. Farley (CERN, Geneva). p.228-34 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

The advantages of mesons(μ) over electrons for probing nucleon structure are summarized, and a meson(μ) storage ring under consideration at CERN for (g-2) measurements and studies of μ-p scattering with polarized mesons(μ) is described. (D.C.W.)

37970 RESONANCE INTERACTION OF π MESONS WITH THE PERIPHERAL SHELL OF A NUCLEON. V. S. Barashenkov and D. I. Blokhintsev (Joint Inst. for Nuclear Research, Dubna, USSR). p.259-62 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

The contribution of peripheral processes was investigated by analyzing hyperon(Λ) production in π^--p interactions at 7 Bev, using the one-meson theory with and without accounting for the resonant π-K interaction. An analysis of the momentum distribution of recoil protons in π^--p interactions indicated resonant interaction of the incident meson(π^-) with a meson(π) in the proton shell. (D.C.W.)

37971 ELECTROMAGNETIC POLARIZABILITY OF NUCLEONS. V. S. Barashenkov and H. J. Kaiser (Joint Inst. for Nuclear Research, Dubna, USSR). p.263-6 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

Relations for determining the electric and magnetic polarizabilities of a proton from Compton scattering are given. Numerical results are compared with theoretical predictions. Determination of the electric polarizability of a neutron from slow neutron scattering by heavy nuclei at small angles is briefly considered, and relations for the polarizability of the electron-pair cloud in nucleons are given. (D.C.W.)

37972 PROTON-PROTON SCATTERING IN THE Gev REGION. G. E. Brown (NORDITA, Copenhagen). p.291-4 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

The disappearance of the hard core in p-p scattering at high energies is explained, and the disappearance of the spin-orbit term is briefly considered. (D.C.W.)

37973 NOTE ON HIGH-ENERGY DIFFRACTION SCATTERING. Loyal Durand, III, and Kenneth R. Greider (Yale Univ., New Haven). p.296-7 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

Data on elastic p-p scattering at very high energies were analyzed using an impact-parameter representation for the scattering amplitude and neglecting the possible spin dependence of the amplitude. Models assuming the scattering amplitude either to be purely imaginary or to have a non-vanishing real part that approaches zero relative to the imaginary part at high energies were used. (D.C.W.)

37974 REGGE TRAJECTORIES FOR INTERACTIONS CONTAINING HARD CORES. J. W. Durso and P. S. Signell (Pennsylvania State Univ., University Park). p.308 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

The analytic behavior of the partial-wave scattering amplitude was investigated as a function of complex angular momentum and real energy for the spin-singlet, even-parity state of the two-nucleon system. (D.C.W.)

37975 COHERENT PRODUCTION AS A MEANS OF DETERMINING THE SPIN AND PARITY OF BOSONS. S. M. Berman and S. D. Drell (Stanford Univ., Calif.). p.312-13 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

The determination of the parity and spin of bosons produced in coherent reactions by analysis of the decay distributions of the bosons is briefly discussed. (D.C.W.)

37976 ON THE RELATIVISTIC THEORY OF COMPOSITE SYSTEMS. G. Domokos (Joint Inst. for Nuclear Research, Dubna, USSR). p.316-19 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

It is shown that composite states can be described by Regge poles in the framework of relativistic field theory. (D.C.W.)

37977 ON SACHS FORM FACTORS AND RELATED TOPICS. S. Bergia and L. Brown (Imperial Coll. of Science and Tech., London). p.320-2 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

The charge and magnetic moment form factors are shown to be equal at the threshold of the crossed channel. The vector meson exchange contribution to π-N scattering is then briefly considered, together with the invariant amplitudes. (D.C.W.)

37978 ISOBARIC MODEL APPLIED TO ELECTROPRODUCTION AND TO RECOIL PROTON POLARIZATION IN ELECTRON-PROTON SCATTERING. M. Gourdin (Faculte des Sciences, Orsay, France). p.325-8 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

The electroproduction of mesons(π) was analyzed reasonably well using the isobaric model. Some qualitative results on the Dirac neutron form factor were obtained. The polarization of the recoil proton in elastic electron-proton scattering was also calculated on the basis of the isobaric model, together with the asymmetry of the recoil proton in elastic μ-p scattering with polarized mesons(μ). (D.C.W.)

37979 ON THE OPTICAL-MODEL THEORY OF SCATTERING WITH LARGE MOMENTUM TRANSFERS. Eugene Guth (Oak Ridge National Lab., Tenn.). p.332-3 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

Two approximations that possibly lead to the required power law for large momentum transfers are discussed. A purely absorptive Yukawa potential and a cutoff Coulomb potential were considered. (D.C.W.)

37980 IMPLICATIONS OF A NEW APPROACH TO QUANTUM ELECTRODYNAMICS IN ELECTRON-PROTON SCATTERING. Mendel Sachs (Boston Univ.). p.336-7 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

A theory is discussed in which the cross section depends explicitly on projectile and target particle fields, which are the solutions of the coupled nonlinear field equations, and on the interaction field amplitude, which relates the projectile and target particle fields. The theory implies that the charged-particle scattering cross section diminishes continuously to zero as the momentum transfer becomes large compared with $(0.2F)^{-1}$. (D.C.W.)

37981 TESTING OF REGGE BEHAVIOR WITH ELECTRON SCATTERING AND PHOTOPRODUCTION. H. Salecker (Universität, Freiburg i. B.). p.338-9 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

Experiments by which the Regge behavior of various elementary particles could be investigated were analyzed. Photoproduction of nucleon pairs in the forward direction appears to be suitable for studying the Regge pole trajectory of the nucleon, while electron scattering by spin-zero targets and photoproduction of electron and meson(μ) pairs in the forward direction at two different energies, but with the same energy-momentum transfer, would serve the same purpose for photons, electrons, and mesons(μ). (D.C.W.)

37982 EVIDENCE FOR A MOLECULAR STRUCTURE OF HEAVY MESONS. E. J. Sternglass (Westinghouse Research Labs., Pittsburgh). p.340-3 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

Evidence is presented that the heavier mesons and the meson(π) resonances can be described in terms of quasi-molecular systems composed of mesons(π) with a single distance between nearest neighbors $d_{\pi\pi}$, a single binding energy per bond $U(d_{\pi\pi})$, and a single zero-point energy. (D.C.W.)

37983 ASYMPTOTIC BEHAVIOR OF TOTAL AND ELASTIC CROSS SECTIONS AND MULTIPLE PRODUCTION AT VERY HIGH ENERGIES. Yoshio Yamaguchi (Tokyo Univ.). p.344-7 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

The asymptotic region is defined for all colliding pairs of strongly interacting particles; and the behavior of the elastic and total cross sections is investigated, with emphasis on the connection with inelastic N-N interaction. (D.C.W.)

37984 THE LINE WIDTH IN ELECTRON-SCATTERING EXPERIMENTS AND THE DETERMINATION OF ABSOLUTE CROSS SECTIONS. G. R. Bishop (Ecole Normale Supérieure, Orsay, France). p.351 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

The factors determining the line width were investigated, and two scattering experiments were analyzed using suitable convolutions of the factors. Support for the radiative corrections usually applied to obtain absolute cross sections was obtained. (D.C.W.)

37985 ELECTRON-PROTON COINCIDENCES FROM INELASTIC ELECTRON-DEUTERON SCATTERING AT $q^2 = 6.8\ F^{-2}$. Donald W. Aitken, Jr. (Stanford Univ., Calif.). p.366-9 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

Scattered electrons were detected in a liquid Cherenkov counter on top a 180°, 500-Mev/c, double-focusing spectrometer; and recoil protons were detected in a ten-channel scintillation ladder on top a 1000-Mev/c, 180° spectrometer. Analysis of the data showed no significant difference between the form factors for a free proton and those for the loosely-bound proton in the deuteron. The final-state N-N interaction was unsuccessfully studied by investigating the angular distribution of outgoing protons. (D.C.W.)

37986 ELASTIC ELECTRON-DEUTERON SCATTERING AT HIGH MOMENTUM TRANSFER. E. F. Erickson (Stanford Univ., Calif.). p.370-3 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

The cross section for electron elastic scattering from deuterium was measured at five values of the four momentum transfer ranging from $q = 2.37$ to $4.10\ F^{-1}$ by detecting recoil protons. The results were compared with the theory of Jankus. (D.C.W.)

37987 SUMMARY OF CONFERENCE RESULTS. Abdus Salam (Imperial Coll. of Science and Tech., London). p.397-414 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

Some of the more significant developments in electron scattering, form factors, symmetries in strong interactions, high-energy scattering, field theory, and S-matrix theory are briefly discussed. (D.C.W.)

Field Theory and Quantum Mechanics

37988 PERTURBATION THEORY IN THE LSZ-FORMALISM. O. Steinmann (New York Univ., New York). Ann. Phys. (N. Y.), 29: 76-100(Aug. 1964).

The theory of a real, scalar, local field satisfying the LSZ-axioms is considered. A perturbative expansion of its retarded functions solving the unitarity equations of Glaser, Lehmann, and Zimmermann rigorously in every finite order of perturbation theory is constructed. The calculations involve only mathematically well defined quantities. No divergences enter at any step. The procedure works for nonrenormalizable theories as well as for renormalizable ones. No essential difference between these two types of theories, which would allow to exclude the former from consideration, was found. (auth)

37989 COUNTING CORRELATIONS IN BOSON BEAMS. Dennis Holliday and Martin L. Sage (Univ. of Oregon, Eugene). Ann. Phys. (N. Y.), 29: 125-57(Aug. 1964).

The photon counting correlation phenomena first observed by Hanbury Brown and Twiss are analyzed using methods from the theories of stochastic processes and quantized fields. It is demonstrated that a quantized field which is excited by a c-number source exhibits counting correlations of the Hanbury Brown and Twiss type when the c-number part of the field is a sample function of a stationary random process with statistically independent modes, an example of which is shown to be the blackbody radiation field. The counting covariance for such fields is found to be the sum of two terms: a quantum mechanical term which is a consequence of the lack of commutability of the field operators and a term which can be derived from classical theory. This result is shown to be consistent with the existing counting correlation experiments. A discussion of the counting correlation effect from the viewpoint of quantum statistical mechanics is given to demonstrate that the bunching of bosons explanation of the effect is, in general, incorrect. Counting correlations in more general types of fields are considered. (auth)

37990 THE PERMUTABILITY OF UNBOUNDED OPERATORS. M. Guenin and B. Misra (Université, Geneva). Helv. Phys. Acta, 37: 233-40(1964). (In French)

The notion of commutativity for unbounded operators is discussed. (auth)

37991 NUMERICAL CALCULATIONS OF THE DELBRÜCK SCATTERING AMPLITUDE. F. Ehlotzky and G. C. Sheppey (CERN, Geneva). Nuovo Cimento (10), 33: 1185-98(Aug. 16, 1964).

Formulas for the imaginary part of the Delbrück scattering amplitude, derived by Kessler some years ago, and a simple fixed-angle dispersion relation, are used to calculate numerically the real and imaginary parts for energies between 1 and 20 Mev and scattering angles from 0 to 120° with an accuracy of at best 5 to 10%. Comparison is also made with some of the experimental data available, and conclusions are drawn for future work. (auth)

37992 MASS RENORMALIZATION IN QUANTUM FIELD THEORY. [PART] I. C. R. Hagen (Univ. of Rochester, N. Y.). Nuovo Cimento (10), 33: 1244-6(Aug. 16, 1964).

It is pointed out that while δm can be nonzero for certain theories, there is no compelling reason to expect this result in the general case. An example of a perfectly well defined field theory in which δm vanishes for a finite-mass fermion independently of the value of Z_2 is presented. The model considered is a special case of a spin-one-half version of Zachariasen's model. (C.E.S.)

37993 UNITARY REPRESENTATIONS OF THE INHOMOGENEOUS LORENTZ GROUP. R. Shaw (Hull Univ., Eng.). Nuovo Cimento (10), 33: 1074-90(Aug. 16, 1964).

A realization of the unitary representation [m,s] of the inhomogeneous Lorentz group is derived, in the case of

nonzero mass, which has simple transformation properties yet has no superfluous spin components. A simple transformation then results in the Wigner realization of [m,s]. It is incidentally pointed out that for $s \neq 0$ the representation [m,s] is equivalent to the tensor product of [m,0] with the representation D(s,0) of the homogeneous Lorentz group. (auth)

37994 TWO INEQUALITIES FOR CLASSICAL AND QUANTUM SYSTEMS OF PARTICLES WITH HARD CORES. O. Penrose (Imperial Coll. of Science and Tech., London). Phys. Letters, 11: 224-6(Aug. 1, 1964).

A lower bound is obtained for the fugacity of a system of particles with hard cores in classical mechanics, and an upper bound is derived for the fraction of condensed particles at absolute zero for the corresponding Bose system in quantum mechanics. (D.C.W.)

37995 GEOMETRIZATION OF A MASSLESS SPINLESS BOSON. R. Penny (Ford Motor Co., Dearborn, Mich.). Phys. Letters, 11: 228-9(Aug. 1, 1964).

It is shown that there is a set of conditions involving only the Ricci tensor and the metric tensor which are necessary and sufficient for the existence of a real scalar function obeying the generalized massless Klein-Gordon equation. (D.C.W.)

37996 SOME REMARKS ON QUANTUM MECHANICS AND THE PRINCIPLE OF EQUIVALENCE. S. T. Epstein (Univ. of Wisconsin, Madison). Phys. Letters, 11: 233-4 (Aug. 1, 1964).

The possibility of mass analyzing a mixture of particles with different masses, but with the same coordinate-velocity distributions by purely gravitational means was previously considered. It is shown that it is probably impossible to find two normalizable wave functions ψ_1 and ψ_2 associated with particles of different masses m_1 and m_2, respectively, such that the coordinate and velocity distributions given by ψ_1 and ψ_2 are both identical. (D.C.W.)

37997 VARIATION PRINCIPLE FOR PROBABILITY AMPLITUDES. K. Mueller (Technische Hochschule, Brunswick). Phys. Letters, 11: 238-9(Aug. 1, 1964).

A variation principle for the probability amplitude between a bound state of a hamiltonian (Schrodinger equation) and a given state is presented. The principle constitutes a linear version of Rayner's principle. (D.C.W.)

37998 ON THE CONSISTENCY OF $Z_3 = 0$ AND FINITE MASS RENORMALIZATION. N. G. Deshpande and I. S. Gerstein (Univ. of Pennsylvania, Philadelphia). Phys. Letters, 11: 264(Aug. 1, 1964).

It is shown that a Zachariasen model exists in which the renormalization constant $Z_3 = 0$ and $\delta\mu^2$ is finite and may be zero, while maintaining a nontrivial S matrix. (D.C.W.)

37999 ON THE EXCITED STATES OF A SYMMETRICAL POLARON MODEL. J. Devreese (Studiecentrum voor Kernenergie, Mol, Belg.) and R. Evrard. Phys. Letters, 11: 278-9(Aug. 15, 1964).

The energy levels of a polaron were investigated in a model consisting of an electron interacting with two polarization waves. The lowest odd level obtained is apparently an internal excitation and continues to exist for intermediate and even for weak coupling. The lifetime of the excited states decreases as the electron-phonon coupling strength decreases. (D.C.W.)

38000 OPERATORS FOR OBSERVABLES IN QUANTUM OPTICS. T. F. Jordan (Universität, Bern). Phys. Letters, 11: 289-91(Aug. 15, 1964).

Annihilation and creation operators are considered for electromagnetic field modes in which photons are produced and for radiation modes in which photons are detected. It is shown that an operator is determined uniquely by its expectation value in every classical state. (D.C.W.)

38001 THE W.K.B. APPROXIMATION FOR BLOCH ELECTRONS WITH AN APPLICATION TO INTERBAND TUNNELLING. P. N. Butcher (Royal Radar Establishment, Great Malvern, Worcestershire, Eng.), D. M. Hum, and E. R. Pike. Proc. Roy. Soc. (London), Ser. A, 280: 185-97(July 21, 1964).

The W.K.B. technique for solving the one-dimensional wave equation is extended to the case when the potential field includes a rapidly varying periodic term as well as a slowly varying term. A pair of auxiliary functions is introduced which are identical to the wave function and its derivative respectively at the edges of the periodic cells, but which have a simple exponential behavior within the cells. The auxiliary functions satisfy a pair of auxiliary (related) differential equations with slowly varying coefficients, which are valid for all energy values. Solution of the auxiliary equations by the well-known W.K.B. technique yields approximations to the wave function. These approximations break down in the neighborhood of the band edges, which are the turning points of the problem. Connection formulas are established across the band edges and employed to calculate the interband tunneling probability. In the immediate neighborhood of a band edge the analysis yields an effective-mass wave equation and a closed form for the wave function. The auxiliary functions are closely related to the effective-mass modulating wave function and the results may be regarded as an extension of effective-mass theory for the one-dimensional case throughout the whole of the energy ranges of allowed bands and forbidden gaps. (auth)

38002 ON THE ENTROPY PROBLEM IN THE THEORY OF MEASUREMENT IN QUANTUM MECHANICS. Saburo Amai (Univ. of Osaka Prefecture, Sakai, Japan). Progr. Theoret. Phys. (Kyoto), 31: 931-3(May 1964).

The large difference between the entropy in the pure and mixed states of the total system (microsystem plus measuring apparatus) is resolved. (D.C.W.)

38003 APPLICATIONS OF GREEN QUANTUM FUNCTIONS IN SCATTERING THEORY. F. A. Zhivopistsev (Scientific-Research Inst. of Nuclear Physics, [Academy of Sciences, USSR]). Vestn. Mosk. Univ., Ser. III, Fiz. Astron., No. 1, 29-36(Jan.-Feb. 1964). (In Russian)

Green functions and Lippman-Schwinger formalism were used to find the bond between the S matrix in the nuclear reaction $A + \alpha \rightarrow B + \beta$ and the corresponding matrix elements in generalized Green's function. It is shown that the S-matrix determination in simple nuclear reactions is related to finding single-particle and two-particle Green functions. (tr-auth)

38004 CERTAIN PROPERTIES OF IRREVERSIBLE QUANTUM MECHANICAL PROCESSES. F. A. Zhivopistsev (Inst. of Scientific-Research in Nuclear Physics, [Academy of Sciences, USSR]). Vestn. Mosk. Univ., Ser. III, Fiz. Astron., No. 2, 8-15(Mar.-Apr. 1964). (In Russian)

A quantum theory of irreversible processes was used in studies of particle scattering in a complex finite magnitude system. An assumption of small energy interaction was used in developing an equation for a single-term density matrix binding the diagonal matrix elements with the nondiagonal ones. The equation obtained differs from the universally known Block equation by a supplementary term

which alters the character of dissipation. The equation was used in the investigation of reciprocally acting oscillators and electron interactions with the radiation field. (tr-auth)

38005 ON ANALYTIC PROPERTIES OF VACUUM EXPECTATION VALUES IN RELATIVISTIC QUANTUM FIELD THEORY. Alagesvaran Chelvanayakam Manoharan. Thesis, Waltham, Mass., Brandeis Univ., 1963. 134p.

Some linear aspects are studied of the Wightman formulation of quantum field theory in terms of vacuum expectation values of field operators. Well-known results on analyticity of Wightman functions in the extended tube T'_n and in the space m_n of scalar product variables, which follow from general physical requirements of Lorentz invariance and positive energy spectrum, are mentioned for the case of neutral scalar fields with the intention of using them for Minkowskian spacetime of arbitrary dimension s. Wightman's methods for finding the boundary of the analyticity domain m_n are rephrased in arbitrary dimension s, and the classification of boundary sets in terms of stability properties under complex Lorentz transformations and linear independence of vectors on the light cone is examined in detail. Necessary and sufficient conditions are given for each set of the main class of sets so that the disjointness of the sets is guaranteed. The dimensions of all the sets are investigated by finding upper bounds for them and lower bounds for some. For functions with $n > \frac{1}{2} s(s-1) + 1$ it is proved that there are no new hypersurfaces apart from pseudocylinders corresponding to functions with smaller n values. The results are related to known ones in (1 + 1) dimensions by using, in the latter, light-cone coordinates due to Jost. A discussion of the holomorphy envelope using local commutativity for the 3 point function is given in terms of Streater domains to illustrate the corresponding (but unsolved) problem for the 4 point function in (1 + 1) dimensions. (A.G.W.)

Geophysics

38006 (A/CONF.28/P/73) THERMALIZATION AND NEUTRON SPECTRA. Michel Cadilhac, Jean-Louis Soule, and Oleg Tretiakoff (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 15p.

The investigation of the neutron spectra in thermal reactors is taking an increasing importance owing to the role played in them by plutonium. Whatever the absorption law, it has been remarked that the scattering law in the moderator affects the spectrum only through certain overall properties. It would thus seem possible to develop a simplified representation of this effect which would lead to a clear understanding of the phenomena, reducing at the same time the volume of numerical calculations required. The synthetic model employed presents the advantage of reducing the determination of the spectra in a homogeneous medium to the resolution of a second-order differential equation, like the Wigner-Wilkins model (monoatomic gaseous hydrogen), and the generalized heavy gas model of J. Horowitz, which, incidentally, are both special cases. The model is sufficiently general to allow a correct treatment of the situations met with in practice, and in particular the important case where the presence of plutonium introduces absorption resonances at low energy. In a heterogeneous medium, the most important factor is the mean spectrum in the fuel of one cell, the knowledge of which is allowed by a generalization of the Amouyal-Benoist-Horowitz method. The proposed model lends itself particularly well to such calculations and allows the effects of rethermalization, e.g., when the cooling system and the moderator are at different temperatures to be treated. Examples are given of practical applications: codes for spectra and effective-cross-section computations (editing of tables); and codes for the treatment of neutron balance in a lattice or for the interpretation of experiments (spectral indices, critical experiments on plutonium, diffusion parameters). (auth)

38007 (A/CONF.28/P/74) IMPROVEMENTS IN METHODS OF NEUTRON CALCULATION FOR THERMAL REACTORS. Roger Naudet, Albert Amouyal, and Pierre Benoist (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 16p.

New theories and calculational methods for thermal neutron lattices are reported. Recent achievements in thermalization theory represent the main improvement in reactor physics, but there are many other problems, and the target is eventually to obtain a better understanding of the overall neutron balance. The following topics are discussed: calculation of the thermal utilization factor in a cell made up of a number of concentric media; relation between the migration area and the distribution in space and energy of the neutron absorptions (cut-off between fast and thermal leakage); determination of the diffusion coefficients in a lattice containing cavities; spectra of slowing down neutrons and calculation of the resonance escape probability; and such specific problems as, applications of heterogeneous methods, resolution of the transport equation in the double Pn code, and fine structure inside fuel bundles. In these various fields important refinements were achieved and are already used in practical lattice calculations. (auth)

38008 (A/CONF.28/P/356) NEUTRON SLOWING DOWN IN HYDROGENEOUS MEDIA. L. N. Yurova, A. A. Poljakov, S. B. Stepanov, and G. A. Alimov (U.S.S.R.). May 1964. 17p.

A study was made of neutron moderation and diffusion in various hydrogenous media. Descriptions are given of the method of measuring neutron spatial distribution in bounded media, and some results of experimental investigation of spatial distribution of neutrons in various media. The effect of dimensions of the neutron fission source and of the geometrical structure of the medium (heterogeneity) on the neutron spatial distribution was determined for those neutrons which have been moderated down to 1.46 ev. Results are presented of the thermal neutron diffusion measurements performed by pulsed technique for a number of hydrogenous substances in a temperature range from melting to boiling. The diffusion coefficient was obtained in the form $D(v) = \text{const.}\ v^a$, where a is the function of molecular structure of the substance. The value D(v) allows one to calculate the transport length and transport cross section per atom of bounded hydrogen. It was found that the value of the transport cross section per atom of hydrogen strongly depends upon the molecular structure of the hydrogenous medium. The example for $[C_{15}H_{16}]$ was a = 2.58, and $\sigma_{t2}^{H} = 86$ barns, for $[C_{12}H_{10}]$ a = 1.33 and $\sigma_{t2}^{H} =$ 31 barns. (auth)

38009 (A/CONF.28/P/357) EFFECTS OF CROSS-SECTION RESONANCE STRUCTURE OF NEUTRON DIFFUSION AND RESONANCE EFFECTS ON FISSIONABLE NUCLEI. L. P. Abagyan, N. O. Bazazyantz, I. I. Bondarenko, et al. (U.S.S.R.). May 1964. 20p.

The way of taking into account the resonant structure of neutron cross-section in reactor theory is considered. These effects are shown to be of considerable and sometimes of major importance for the determination of neutron

space energy distributions even for the fast reactors. The method is developed for taking into account the resonant structure in multigroup reactor calculation for Pn- and Sn-approximations. The theory for evaluation of resonant structure parameters is described for different energy ranges. For isolated levels this theory is rigorous but only qualitative estimates of the effects in question can be made for partially overlapping resonances. It is shown that because of the interference between potential and resonant scattering the cross-section fluctuations in the region of overlapping resonances are strong enough for resonant self-shielding to be quite significant in this energy range. Some methods are described for measuring parameters of resonant structure of cross-sections which affect the neutron diffusion in media. These methods do not require high-energy resolution and can be applied at any neutron energy including the region of overlapping levels. The experimental results obtained by these methods are summarized and compared with theory. Some theoretical concepts of fission-channel scheme were used to make reasonable choice of the mean values and statistical distributions of fission widths of the resonant structure. The Bohr-Wheeler formula for average fission-widths was used to analyze experimental data for reactions (d,pf), (n,f) and (γ,f). These data are found to be in agreement with the concept of fission channels proposed by Bohr, negative parity channels being by 0.6 to 0.8 Mev above the first positive parity channel. The Bohr-Wheeler formula is shown to describe quantitatively the fission widths of neutron resonance of ^{233}U, ^{235}U, and ^{242}Pu. ^{239}Pu must be assumed to have the ground state of negative parity to explain the sharp disagreement between theory and experiment for this nucleus. Experimental distributions of fission and reduced neutron widths of neutron resonances were analyzed. The existence of two sub-systems of resonances with different spins and possible omission of weak levels were considered. Resulting numbers of fission channels are N = 1 for ^{239}Pu and N ≥ 3 for ^{233}U. The dependence of $\bar{\alpha} = \bar{\sigma}\gamma/\bar{\sigma}$ on energy for s- neutrons was calculated ($\alpha = \bar{\Gamma}\gamma/\bar{\Gamma}_t$ was taken to be constant). $\bar{\alpha} > \alpha$ always the difference between two values being especially large at neutron energy $E_n \sim 100$ ev. With an increase in neutron energy when the contribution of neutron width increases and fluctuations of the total width decrease, the value of $\bar{\alpha}$ approaches α, i.e. diminishes even before neutron p-wave becomes significant. The maximum effect of this kind is expected for ^{239}Pu, the nucleus with the most broad distribution of fission widths and with greatest reduced neutron width. These results were used for calculating temperature effects for ^{239}Pu. (auth)

38010 (A/CONF.28/P/365) CALCULATION OF SLOW ENERGY NEUTRON SPECTRA. G. I. Marchuk, G. A. Iljasova, V. N. Morozov, V. V. Smelov, and V. A. Hodakov (U.S.S.R.). May 1964. 16p.

Methods of calculation of slow neutron spectra are reviewed. A multi-group kinetic equation is given for the flux and value of neutrons. Methods were devised whereby the slow neutron spectra can be calculated using the spherical harmonic method, Carlson method, and Monte-Carlo method. A comparative analysis is made of the calculations of the neutron spectra by different methods. Angular distributions of the neutron flux are given. The calculation results are compared with the experimental data obtained in the Kurchatov Atomic Energy Institute. (auth)

38011 (A/CONF.28/P/366) NEUTRON THERMALIZATION STUDIES IN HYDROGENOUS MEDIA. E. Ya. Doilnitsyn, A. G. Novikov, G. A. Ilyasova, M. V. Panarin, V. V. Smelov, I. P. Stakhanov, A. S. Stepanov, and A. I. Stupanov, (U.S.S.R.). May 1964. 16p.

An investigation was made of thermal neutron spectra for water and graphite–water reactors by means of the time-of-flight method. Space and energy distribution of neutrons in water with a Fermi-spectrum source is presented. Neutron spectra are measured in water poisoned by an absorber according to 1/v law. The results are compared with the calculations for a gas model, taking into account the chemical binding forces. The relaxation of a neutron gas temperature in water was studied. Two approaches are considered fairly explaining the asymptotic spectrum for thermal neutrons. The results of measurement and those of calculations with P-3 approximations are given for several types of graphite–water reactor lattices, taking into account the thermalization effects. (auth)

38012 (A/CONF.28/P/367) EXPERIMENTAL STUDIES ON NEUTRON THERMALIZATION. V. I. Mostovoy, V. S. Dykarev, I. P. Eremeev, S. P. Ishmaev, I. P. Sadikov, Yu. S. Saltykov, V. A. Taraban'ko, and A. A. Chernyshov (U.S.S.R.). May 1964. 19p.

Experimental work is reviewed on neutron thermalization carried out in the Kurchatov Atomic Energy Institute. This work deals with the most interesting aspects of neutron thermalization of practical importance carried out along three lines: inelastic scattering of slow monochromatic neutrons on bound nuclei of the moderator; establishment of the thermal neutron spectrum in time in various moderators; and thermal and slowing-down neutron spectra in homogeneous and heterogeneous media. (auth)

38013 (A/CONF.28/P/368) EXPERIMENTAL STUDIES ON FAST-NEUTRON REACTOR PHYSICS. A. I. Leipunskii, I. I. Bondarenko, O. D. Kazachkovskii, et al. (U.S.S.R.). May 1964. 24p.

An experimental study was made of some problems of fast-neutron reactor physics. The studies continue a series of experiments on fast reactor physics that has been carried out at the Physical-Energy Institute since 1950. The following problems are considered: refinement and development of multigroup cross-section sets for nuclear reactors calculation; studies of neutron propagation in large blocks of material performed on BR-I reactor are described; the BFS reactor for large fast-neutron critical assembly investigations; and radiative-capture cross-section measurements on fissionable isotopes for neutron spectra of the BR-5 core and reflector. (auth)

38014 (AFCRL-64-529) METHODS FOR OBTAINING ELECTRON DENSITY PROFILES FROM CAPACITIVE IONOSPHERIC ROCKET PROBES. Scientific Report No. 208. P. E. Crouse (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). May 15, 1964. Contract AF19(628)-4050. 63p. (AD-603625)

Two rockets were fired in July, 1963 at Fort Churchill, Canada, in which the nosecone was insulated and the resistive and capacitive components of the admittance of two frequencies were measured between this insulated portion of the rocket and the main rocket body. A previous report by Herman has described the theory on which the reduction of these measurements to electron density and collision frequency profiles can be accomplished. This procedure has since been modified to utilize the Sen-Wyller generalization of the Appleton-Hartree equation and was applied to the analysis of the two experiments. The first firing took place during the solar eclipse of 20 July, 1963 at 4:05 p.m. L. M. T. when the percentage of totality was approximately 93%. The second firing took place on 26 July, 1963 at approximately the same local time. Electron density and col-

lision frequency profiles for the two experiments are presented. (auth)

38015 WHISTLER MEASUREMENTS OF ELECTRON DENSITY IN THE MAGNETOSPHERE. D. L. Carpenter and R. L. Smith (Stanford Univ., Calif.). Rev. Geophys., 2: 415-41(Aug. 1964).

The whistler method of measuring electron density in the magnetosphere is discussed. Particular attention is devoted to certain questions that may perplex workers outside the whistler field. Profiles of equatorial electron density deduced from whistlers are compared and are found to be in general agreement. Whistler results on the knee in the equatorial electron density profile and on values of electron density near 2 earth radii geocentric distance are found to agree with corresponding results obtained by independent methods of measurement. (auth)

Low Temperature Physics

38016 (AD-438181) SUPERCONDUCTIVITY, 1961–1962: AN ANNOTATED BIBLIOGRAPHY. Jack B. Goldmann, comp. (Lockheed Missiles & Space Co., Sunnyvale, Calif.). Apr. 1963. 206p. (SB-63-33)

Applications, properties, theory, and preparation of superconductors are reviewed in 525 references. Indexes to author and subject are given. (R.E.U.)

38017 (APCI-541301) ENERGY DEPOT CRYOGENIC FUEL STORAGE AND DISTRIBUTION SYSTEM. PHASE I. CONCEPTUAL DESIGN STUDY. Final Technical Report. R. G. Clark, A. Karalis, A. Lapin, H. C. Rowles, and P. D. Stelts (Air Products and Chemicals, Inc., Allentown, Penna.). Aug. 1964. Contract AT(30-1)-3129. 215p.

The conceptual design of the system for distributing liquid hydrogen produced by the Nuclear Powered Energy Depot to fuel users (e.g., vehicles) is presented. Also reported are studies for feasibility demonstration of an advanced design concept for light-weight, compact, low heat-leak, and rugged 50-gallon liquid hydrogen vessels for the Energy Depot System. (auth)

38018 VARIATIONAL PRINCIPLE IN THE THERMODYNAMICS OF SUPERCONDUCTING SYSTEMS. M. E. Polistrant and V. A. Moskalenko (Inst. of Physics and Mathematics, Academy of Sciences, USSR). Fiz. Metal. i Metalloved., 17: 827-33(June 1964). (In Russian)

The superconducting state of a metal is studied by means of Frolich's model, allowing for Coulomb interaction between electrons. The thermodynamic potential of the system is given in the form of a functional of the free electron and phonon functions of Green. It is shown that this functional has the property of a steady state with respect to the independent variations in the electron and phonon functions of Green and also the mass and polarization operators. An expression for the second variation of this functional is derived. (OTS)

38019 THE EFFECTIVE MASS OF THE CONDUCTION ELECTRONS IN METALS AND THE THEORY OF SUPERCONDUCTIVITY. J. O. Linde (Royal Inst. of Tech., Stockholm). Phys. Letters, 11: 199-201(Aug. 1, 1964).

A model for superconductivity is proposed, based on the implications of magnetic susceptibility measurements on manganous formate powders and crystals for the spin order at low temperatures and on theoretical consideration of the effective mass of the conduction electrons. (D.C.W.)

38020 THE CRYSTAL STRUCTURE OF SOLID DEUTERIUM. M. Brith and D. White (Israel Inst. of Tech., Haifa). Phys. Letters, 11: 203-5(Aug. 1, 1964).

The structures of solid D_2 and H_2 were investigated by evaluating the coefficients in an expression for the anomalous heat capacity associated with the quenching of molecular rotation in the rigid lattice for two variations of hexagonal close-packed structure and for body-centered tetragonal structure. The results were compared with values derived from the experimental heat capacities of solid D_2 and H_2. (D.C.W.)

38021 THE ELECTRICAL RESISTIVITIES OF THREE GADOLINIUM–YTTRIUM ALLOYS. J. Hennephof (Inst. for Crystal Physics, Groningen, Netherlands). Phys. Letters, 11: 273-4(Aug. 15, 1964).

The temperature dependence of the electrical resistivity of three Gd–Y alloys containing 4.5, 16, and 30% Y, respectively, and of a pure Gd sample was measured between 77 and 380°K. The resistivity was also measured at 4.2°K. A conspicuous change in the slope of the curves was interpreted as a change from ferro- to paramagnetic ordering. The total disorder resistivity at 0°K and in the paramagnetic region was obtained, and the Y content was extrapolated to 100%. (D.C.W.)

38022 DISORDER RESISTIVITY IN RARE EARTH ALLOYS. A. J. Dekker (Inst. for Crystal Physics, Groningen, Netherlands). Phys. Letters, 11: 274-5(Aug. 15, 1964).

The disorder resistivity in concentrated binary alloys A_xB_{1-x}, which are ferromagnetically ordered at zero temperature and contain localized magnetic moments, was calculated using a Nordheim approximation extended to include spin-dependent scattering. The resistivity in the region of complete spin disorder and at zero temperature was obtained. (D.C.W.)

38023 EFFECTS OF HELIUM TEMPERATURE STRAIN ON THE SUPERCONDUCTING TRANSITION OF Pb–In ALLOYS. J. F. Schenck, J. S. Willis, and R. W. Shaw (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Letters, 11: 285-6(Aug. 15, 1964).

The conductivity of In–Pb wires plastically deformed under tension at He temperatures was investigated in both longitudinal and transverse magnetic fields. In a transverse field, the resistance minimum previously noted in Nb and transition metal alloys was induced and intensified by deformation. The effect was annealed at temperatures below 150°K. The current carrying ability was also increased by strain and annealed at low temperatures. (D.C.W.)

38024 THE BEHAVIOR OF SUPERCONDUCTING THIN FILMS IN THE PRESENCE OF MAGNETIC FIELDS AND CURRENTS. Kazumi Maki (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 31: 731-41(May 1964).

The general Gor'kov equation in the presence of arbitrary vector potential is solved for a superconducting thin film, assuming that the ordering parameter Δ is constant all over the specimen and that $l/\xi_0 \ll 1$, where l is the mean free path of an electron and ξ_0 is the coherence length of an electron pair. It is shown that the phase transition due to magnetic field is always of the second order. The critical field is determined from the condition $\Delta = 0$. (auth)

38025 MICRO REGION STUDY ON SUPERCONDUCTING Nb–Sn SCATTERING PROBES. L. Rinderer, J. Wurm, W. Zuellig, and Z. de Beer (Université, Lausanne, Switzerland). Z. Physik, 179: 407-24(1964). (In German)

The decomposition of Nb–Sn diffusion layers was investigated by refined methods. Micro-region x-ray analysis showed, together with anodic oxidation, the existence of four intermetallic Nb–Sn compounds. Nb_3Sn in stoichio-

metric composition was found in none of the samples. The phase responsible for high-field superconductivity has the β tungsten structure with the composition of approximately $Nb_{0.80}Sn_{0.20}$. (tr-auth)

38026 DENSITY MODULATION AND SUPERCONDUCTIVITY IN A SYSTEM OF FERMIONS. H. Horner (Technische Hochschule, Munich). Z. Physik, 180: 198-208 (1964).

An antisymmetrized product of periodic density modulated one-particle functions is investigated as a trial wave function for different local two-body forces. The model is compared with a BCS ground state. For some potentials a lower ground state energy was found for the density modulated state. In lowest order cluster expansion forces with a hard core were examined. A liquid-solid transition is indicated for ^3He at a density near the experimental value. (auth)

38027 FAR INFRARED ABSORPTION IN SUPERCONDUCTING LEAD ALLOYS. James David Leslie. Thesis. Urbana, Ill., Univ. of Illinois, 1963. 98p.

Measurements were made of the absorption of far infrared radiation in the surface of bulk superconducting lead alloys. The absorption curves all have distinct gap edges, and the resulting energy gap values are tabulated. The energy gap values for the lead-thallium samples were compared with critical temperature measurements. For thallium concentrations up to 8 atomic percent, the fractional change in Δ is equal to the fractional change in T_c. However for 10 atomic percent thallium, the fractional decrease in Δ is significantly larger than the fractional decrease in T_c. Structure on the absorption curve below the gap, seen previously in pure Pb and Hg, is found in all the alloy samples. Its presence in heavily doped alloy samples would seem to eliminate gap anisotropy as a possible cause of the structure. The energy at which it occurs does not shift significantly with alloying. The absorption edges for all the samples are much steeper than predicted by theory. (Dissertation Abstr., 24: No. 12, Pt. I (June 1964))

38028 SURFACE RESISTANCE OF SUPERCONDUCTORS. Luc A. Leplae. Thesis, College Park, Md., Univ. of Maryland, 1962. 99p.

This dissertation can be divided into two parts: (1) the study of the real part of the conductivity of a superconductor, $\sigma_1(\omega,g,l)$, where ω, g and l are the frequency, wave number, and mean free path; and (2) the application of the formulas obtained to the study of the surface resistance, $R(\omega)$. In the first part a simple analysis of the BCS model shows that the conductivity of a superconductor can be expressed as an integral of the conductivity of the corresponding normal metal weighed by the coherence factor. A general formula for $\sigma_1^s(\omega,g,l)$ can thus be deduced. In particular, this formula can be applied to the case of pure metals. Exact expressions for $\sigma_1(\omega,g)$ in terms of elliptic integrals are developed. The discussion is illustrated by a geometrical representation. In the second part the formulas found for $\sigma_1(\omega,g,l=\infty)$ are used to compute several curves of $\sigma_1(\omega,g,l=\infty)$, $\sigma_2(\omega,g,l=\infty)$ and $R(\omega)$. The curves obtained for $R(\omega)$ are monotonic and perfectly smooth and do not show the anomalies found in the experiments. The study of the case of impure metals is much more difficult. The analysis is based essentially on the knowledge of the curve $\sigma_1(\omega,o,l)$. The hypothesis is made that above the gap, the effect of the impurities cancels almost completely in the difference $R^s(\omega,l) - R^N(\omega,l)$. This hypothesis is justified as well as possible. (A.G.W.)

38029 A MICROSCOPIC THEORY OF SUPERCONDUCTIVITY FOR THIN FILMS. Stephan Jacques Krieger. Thesis, Berkeley, Calif., Univ. of California, 1963. 37p.

A microscopic theory of superconductivity, based on the model of Bardeen, Cooper, and Schrieffer, is presented to describe the properties of thin superconducting films. Cooper pairs are formed from one-electron states that have wave functions that vanish at the film boundary rather than the usual plane wave states appropriate to a bulk medium. The excitation spectrum is calculated and is found to be the same as that for a bulk medium. Calculation of the weak field magnetic susceptibility leads to a considerably lower value than previous results. (Dissertation Abstr., 24: No. 12, Pt. I (June 1964))

38030 A STUDY OF SOME ELECTRON TUNNELING PHENOMENA IN SUPERCONDUCTORS AND MAGNETO-TUNNELING IN InAs ESAKI DIODES. Barry Norman Taylor. Thesis, Philadelphia, Univ. of Pennsylvania, 1963. 273p.

Current-voltage (I-V) measurements were carried out on several Al-Al, Sn-Sn, Pb-Pb, Sn-In, and Sn-Tl superconducting tunnel junctions. Several samples exhibited pronounced deviations from the theoretical I-V curves. These deviations, in the form of polarity independent excess currents, are attributed to double particle tunneling involving superfluid electrons as proposed by Schrieffer and Wilkins, and to thermally assisted single particle processes involving phonons. One type of excess current is not presently understood. The theoretical possibilities of using superconducting tunnel junctions as quantum detectors of submillimeter and microwave radiation are considered. Included are discussions of the type structure best suited for such a device, thickness of the films required, signal to noise ratio, output signal to noise ratio, output signal and circuitry, and the lifetime for normal quasi-particle recombination. Indications are that tunnel junctions may be successfully used as radiation detectors provided fabrication difficulties are overcome. A direct measurement of the quasi-particle recombination lifetime in Al using an electrical injection technique is described. A double junction transistor like structure consisting of Al-Al oxide-Al-Al oxide-Al was fabricated, and the change in current through one of the junctions measured as the current through the other junction was varied. Finally, some I-V and dI/dV-V measurements on three InAs Esaki diodes in static magnetic fields to 30 Kg and at room, liquid nitrogen, and liquid helium temperatures are discussed. Current-magnetic field measurements were also made at these same temperatures on one sample in pulsed fields to 120 Kg. Data obtained for the field perpendicular to and parallel to the tunnel current and for forward and reverse bias voltages is analyzed using the theory of Haerring and Adams. It is found that the theory is quite adequate for describing the experimental results. (A.G.W.)

Neutron Physics

Refer also to abstracts 37142, 37741, 37942, and 38310.

38031 (A/CONF.28/P/360) THE CHEMICAL BINDING EFFECT ON NEUTRON THERMALIZATION. L. V. Maiorov, V. F. Turchin, and M. S. Yudkevich (U.S.S.R.). May 1964. 18p.

The effect of chemical binding on the integral and differential scattering characteristics and on the formation of slow neutron spectra in the moderators C, H_2O, Be, ZrH, and LiH is discussed. The differential scattering cross sections, calculated with the aid of the UPRAS code which takes account of the acoustic, optical, and diffusive motions of the atoms, are used for the analysis of the neu-

tron spectra in heterogeneous media, media with a temperature gradient, and media with a pulsed source. (auth)

38032 (A/CONF.28/P/362a) STUDY OF BERYLLIUM AND BERYLLIA AS NEUTRON MODERATORS. I. F. Zhezherun, A. K. Krasin, G. I. Plindov, I. P. Sadikov, V. A. Tarabanko, and A. A. Chernyshev (U.S.S.R.). May 1964. 16p.

Results are presented of studies of the scattering, diffusion, moderation, slowing-down, and multiplication (due to the $^{9}Be(n,2n)$ reaction) of neutrons by Be and BeO. The effects of BeO microstructure and temperature on the thermal neutron scattering cross section were studied. Data are presented on the fast neutron multiplication in Be. (D.L.C.)

38033 (A/CONF.28/P/401) ANALYTICAL METHODS IN ENERGY-DEPENDENT TRANSPORT THEORY. Hans Hejtmanek (Österreichische Hochschule, Vienna. Atominstitut). May 1964. 8p.

The time-dependent neutron density in six-dimensional configuration space is of fundamental importance for the computation of the various parameters and functions describing a reactor. It is a solution of the Boltzmann equation with special boundary and initial values determined by the reactor under consideration. Using the theory of linear operators in Hilbert space, two major examples are considered in detail: the stationary neutron spectrum in an unbounded reactor, and the time dependence of the neutron density in a slab reactor. It is expected that good approximation methods can be derived with an arbitrarily given degree of accuracy. (M.J.T.)

38034 (A/CONF.28/P/410) AN APPROACH TO THE SOLUTION OF THE TWO-GROUP NEUTRON DIFFUSION EQUATIONS IN XY GEOMETRY. Timo Toivanen (Finland. Teknillinen Korkeakoulu, Otaniemi). May 1964. 12p.

A new semianalytical technique is described for finding the eigenvalues and the two-group fluxes in a two-dimensional rectangular reactor core surrounded by an infinite homogeneous reflector. The method of solution is an extension of the technique previously developed for one-dimensional problems. By introducing Green's functions for the infinite reflector region, the group diffusion equations and the corresponding boundary conditions are converted into a system of two-dimensional integral equations. In solving these equations the double Hankel transformation is applied. In the Hankel transformed Fredholm equations of the second kind the integral operators can be approximated by degenerate ones, and the problem reduces to the solution of infinite systems of linear algebraic equations. Solving the corresponding truncated finite system an approximate solution is constructed in transform space. The corresponding solution in coordinate space is then found by an inverse Hankel transformation. The method is not restricted to two-dimensional problems. Problems involving more complex reactor configurations, e.g., a three-dimensional, completely reflected rectangular block or a finite cylindrical core with both radial and axial reflectors, are also amenable to treatment by the method. (auth)

38035 (A/CONF.28/P/498) EIGENFUNCTION EXPANSION METHOD IN NEUTRON TRANSPORT THEORY. R. Zelazny (Polish Academy of Sciences. Inst. of Nuclear Research, Swierk). May 1964. 8p.

The paper is devoted to the general solution of the Boltzmann equation of neutron transport theory by means of the eigenfunction expansion method. The method is described on the basis of the one-group Boltzmann equation with isotropic scattering of neutrons for arbitrary geometry. The fundamental notion of the eigenfunction and the eigenvalue of this equation is introduced and their properties are discussed. Then the general solution of the Boltzmann equation is constructed and the boundary value problem formulated. Some examples of problems with different symmetry properties are given. Other efforts in this direction based on different ways of attack are reviewed critically and commented; this relates specially to spherically symmetric problems. This approach is extended later taking into account the anisotropic scattering of neutrons, energy dependent kernels, and time-dependent problems in plane geometry. The eigenvalues and corresponding eigenfunctions for these cases are discussed and the appropriate completeness theorems are sketched. The possible applications of this approach to critical and spectral problems in reactor theory are formulated and examined. The most important information concerning the theory of singular integral equations and basic mathematical concepts relevant from the point of view of their application in neutron transport theory is given and discussed. Special attention is paid to the problem of reduction of the singular integral equations to the Fredholm ones, and to the additional conditions which must be satisfied by their solutions. These conditions are connected intimately with the indices of singular integral equations and play the most important, physical role in the theory. (auth)

38036 (A/CONF.28/P/509) STUDIES OF NEUTRON THERMALIZATION BY A MODIFIED PULSED-SOURCE TECHNIQUE. E. Friedman (Hebrew Univ., Jersualem). May 1964. 20p.

The conventional pulsed-source technique is used as a source of information on the thermalization processes of neutrons in moderating assemblies. A new method for measuring neutron thermalization parameters was tested. The theory and results are presented. The experiment was performed in H_2O, as the method in its present form is most suitable for the study of homogeneous systems in which strong non 1/v absorbers can be dispersed. The experimental set-up is described, and details are given of the geometrical arrangement used to suppress some of the higher harmonic modes. Details of two special methods for the analysis of experimental results are given. These methods enable the use of data taken at quite short delays after the burst of fast neutrons. The results for H_2O at 23°C can be described by $\gamma_{11} = (0.210 \pm 0.026)$ cm^{-1}. This result differs significantly from results obtained by diffusion-cooling measurements, and from calculated values based on Nelkin's model for H_2O. These discrepancies are discussed, as well as the feasibility of the method for the study of different systems. (auth)

38037 (A/CONF.28/P/643) ANALYTICAL TREATMENT OF NEUTRON THERMALIZATION IN TWO-MEDIUM WIGNER SEITZ CELLS OF CYLINDRICAL SYMMETRY. Heinrich Kuesters (Kernforschungszentrum, Karlsruhe, Germany). May 1964. 12p.

An analytical method is presented for solving the thermalization problem in space and energy for a cylindrical Wigner-Seitz cell, containing an infinitely long fuel rod surrounded by a moderator, which is treated as a monatomic gas. The energy loss of scattered neutrons in the fuel is neglected. The Boltzmann equation is solved in both media by expanding the neutron distribution and the transfer scattering cross section in spherical harmonics. A system of coupled integro-differential equations results for the energy and space dependent expansion coefficients. This system first is solved for epithermal neutron energies ($\epsilon \gtrsim 16$ kT). In this region one can describe the energetic behavior of the spectrum by a power series in $1/\sqrt{\epsilon}$ if one

considers $1/\sqrt{\epsilon}$ absorption only. In this region one cannot deal with the slowing down kernel for zero moderator temperature. Therefore all scattering integrals have been evaluated analytically with the asymptotic representation of the correct kernel. This procedure leads to a system of inhomogeneous differential equations, which can be solved by the modified Bessel functions of the second kind. The free constants in the fuel and moderator solutions are determined by the cell boundary conditions. The epithermal solution is extrapolated to zero energies by multiplying with a "damping" function which vanishes with a sufficiently high power for $\epsilon \to 0$. Then the difference between the true spectrum and this artificial function is expanded in a system of orthonormal functions with an exponential asymptotic behavior. The result is an inhomogeneous equation for this difference spectrum. If one deals with the unsymmetrized scattering kernel, the basis functions have to obey a certain condition, which guarantees the detailed balance of the representation of the kernel in this system. On the other hand the adjoint functions also have to include an exponential factor, because otherwise the expansion coefficients of the inhomogeneity may become infinity. The general calculation to get the difference spectrum is straightforward. The homogeneous solution of the inhomogeneous equations in both the moderator and fuel media lead to an eigenvalue problem. This method was first applied to the infinite medium case to look for convergence questions and consistency. As a test the integral neutron balance was calculated. The result is much better than one percent with four basis functions and an asymptotic expansion up to $1/\epsilon^4$. The cell calculations, done in a consistent P_1 approximation, reproduce also the balance better than one percent with an epithermic expansion up to $1/\epsilon^2$. The dependence of the spectra on the moderator mass is investigated, as is the influence of anisotropic scattering. It is seen that the average fuel spectrum deviates appreciably from the fuel boundary spectrum. The mathematical formulation is carried on to the P_3 approximation, but numerical calculations have been done only in the P_1 approximation. (auth)

38038 (A/CONF.28/P/651) THERMAL NEUTRON CROSS SECTIONS AND DIFFUSION PARAMETERS IN SEVERAL ORGANIC MATERIALS. L. Pál, E. Kisdi-Koszó, L. Bod, Z. Szatmáry, and I. Vizi (Magyar Tudomanyos Akadémia Központi Fizikai Kutató Intézete, Budapest). May 1964. 16p.

The temperature dependent transport cross section can be obtained from the integral scattering cross section using the Radkowsky prescription which is rather useful but theoretically not rigorous. A detailed analysis of the Radkowsky prescription on the base of integral cross section and diffusion parameter measurements in several organic liquids (benzene, cyclohexane, n-hexane, toluene, xylene, and diphenyl) are given. The energy dependence of the integral neutron cross sections was measured by time of flight technique and calculated on the base of Zemach-Glauber's theory. The calculated data are in good agreement with the experimental results. The diffusion parameters were obtained from the measurements carried out with the pulsed neutron source method. The average transport cross section obtained from the cross section measurements was compared with the results of the pulsed source measurements. The comparison shows that using the Radkowsky prescription the calculated values of the transport cross sections are in fairly good agreement with those of the pulsed source measurements. The transport cross sections were also calculated from the data of $\sigma_s^H(E)$ for 1,3-butadiene since Petric et al. proposed the use of these data for the calculation of the transport cross sections in various hydrocarbons. Unfortunately the 1,3-butadiene data do not give satisfactory results; therefore, the knowledge of the energy dependent cross section seems to be important in each of the investigated hydrocarbons for the calculation of the average transport cross section. As a conclusion it should be emphasized that the Radkowsky prescription is to be considered rather as a useful tool, not as a theoretically rigorous treatment of the neutron scattering in moderators. (D.L.C.)

38039 (A/CONF.28/P/652) STATISTICAL THEORY OF NEUTRON CHAIN REACTIONS. L. Pál (Magyar Tudományos Akadémia Központi Fizikai Kutató Intézete, Budapest). May 1964. 15p.

A statistical theory is developed for the chain reactions in nuclear reactors. The probability distribution function (PDF) for the number of neutrons in a given state is derived with assumptions of quite general character. From the PDF the fundamental equation for the generating function is obtained permitting the calculation of the expectation value and the variance of the neutron density. Equations are derived for the PDF of the number of fissions and neutrons counted during a given time-interval. Several limit theorems are derived for the generating functions. These theorems are important in various applications of the theory. The multi-group approximation is introduced into the framework of the statistical theory. Several applications are illustrated. The fluctuation of the neutron yield in pulsed fast reactors is considered and the theory of the prompt neutron period measurements in thermal reactors is developed on the base of neutron density fluctuations. (D.L.C.)

38040 (A/CONF.28/P/653) A STUDY ON THE DIFFUSION LENGTH OF THERMAL NEUTRONS IN TERPHENYL (SANTOWAX-R) AT HIGH TEMPERATURES UP TO 400°C. Shiro Hohki, Yoshio Tsuji, Takeo Matsubara, Takeshi Mukaiyama, and Hiromitsu Tada (Sumitomo Electric Industries, Ltd., Osaka). May 1964. 11p.

The temperature dependence of diffusion length of thermal neutrons in terphenyl ($C_{18}H_{14}$) was measured in the wide range from 200°C to 400°C continuously, and the transport cross section was studied in connection with the results. From the results in comparison with the calculated value, using $\delta_S(E)$ from Brugger's experimental data on the scattering law about Santowax-R, it is clear that there is still a problem in assuming that the diffusion length varies as $1/\rho\sqrt{T}$ at high temperature over 300°C, and it might be considered that the temperature dependence of the diffusion length in hot water would be deduced from an analogy of this work. Uniformity of temperature distribution geometrically during the experiments, the figure of the flux including the effect of the epithermal neutrons, and measurement of the neutron flux, that is, the difficulty of using cadmium and indium foils due to the high temperature, i.e., development of gadolinium and dysprosium foils are discussed. (auth)

38041 (A/CONF.28/P/668) MULTI-GROUP CONSTANTS FROM INTEGRAL DATA. M. Humi, J. J. Wagschal, and Y. Yeivin (Hebrew Univ., Jerusalem). May 1964. 12p.

The G-group approximation in neutron transport calculations consists of replacing the correct, energy-dependent, Boltzmann equation, by the set of G-coupled equations $\cdot \vec{\Omega} \cdot \nabla\Psi_g + \alpha_g \Psi_g = 1/4\ \pi\gamma \Sigma_g^G{}_{,1} \beta_{gg'} \varphi_{g'}\ g = 1, 2, \ldots G$ where Ψ_g and φ_g are the group angular and scalar fluxes, respectively. For simplicity, isotropic scattering was as-

sumed. These equations involve G(G + 1) constant coefficients, the determination of which is usually a very delicate problem. (When anisotropic scattering is considered, the source terms are modified and involve more constants.) The common practice in determining these so-called group constants is to start from a set of basic cross sections which are then averaged with a proper weight function over the energy groups. However, there exists to date no satisfactory complete set of basic cross sections, and furthermore, one is not sure what the proper weighting function is. Several unsuccessful attempts were made to derive sets of universal group constants for many-group calculations. Certainly one cannot expect to derive by these conventional methods reasonable constants for fewer-group calculations, applicable to a variety of systems. In principle it should be possible to derive the multi-group constants from integral data, rather than from the actual basic cross sections. This approach is illustrated and discussed. (auth)

38042 (A/CONF.28/P/673) THE TEMPERATURE DEPENDENCE OF NEUTRON INELASTIC SCATTERING ON HEAVY WATER. N. Mateescu, H. Teutsch, V. Nahorniak, A. Diaconescu, and P. Timis (Academia R. P. R. Institutul de Fizică Atomică, Bucharest). May 1964. 16p.

The scattering of cold neutrons on heavy water was studied, using the filter technique for producing the cold neutron beam and the time-of-flight method for the analysis of scattered neutron spectra. For the achievement of an optimal ratio of cold neutrons to thermal and epithermal ones, a filtration assembly formed by a beryllium polycrystalline filter and a lead monocrystal was chosen. The overall time-of-flight resolution of the device of 3.5% has been obtained using a curved slit chopper in optimal transmission regime for 4 Å neutrons. The measurements were extended over an angular range of 30 to 90°, the sample temperature varying between −100°C and +80°C. The obtained curves have been corrected for background, chopper transmission, scattering and absorption in air, and counter efficacity. The diffusive properties of heavy water dependent on temperature have been obtained by detailed analysis of the quasielastic scattering peaks. The results have been compared with theoretical models, viz. with Vineyard's model (continuous diffusion) and Singwi-Sjölander model (jump diffusion), respectively, and also with the experimental results obtained in other laboratories. A quantum level superimposed on the quasielastic peak was also detected; it is probably due to a fine structure having the same order of magnitude as that obtained by Hughes et al., in the case of light water. In the inelastic scattering region, a succession of peaks have been observed which have been ascribed to the heavy water molecule rotation vibration levels. As the target temperature decreases down to −100°C, there occurs a significant modification of the inelastic scattering spectra. (auth)

38043 (A/CONF.28/P/678) DEVELOPMENT OF THE PULSED NEUTRON SOURCE TECHNIQUE AT THE JUNTA DE ENERGIA NUCLEAR. F. Verdaguer, M. A. Vigón, F. Cordero, B. Garcia-Castañer, and E. R. Mayquez (Spain. Junta de Energia Nuclear, Madrid). May 1964. 15p.

Some applications of the pulsed neutron source technique, the results obtained, and the measurements in progress are presented. A 600-kv Cockcroft-Walton accelerator was used as a neutron source; the neutrons bursts are obtained by pulsing a Penning type ion source. The diffusion parameters of light water were measured. The connection between the cooling effect coefficient, c, and the mean square energy transfer M_2, suggested the possibility to perform a measurement of M_2 through the perturbations that are produced on the capture and diffusion constant of non-1/v capturing media. These media were obtained by dissolving different amounts of cadmium in light water. Those perturbations depend on the cadmium concentration, on the temperature dependence of the effective cross section of cadmium, and on M_2. From this measurement a value, $M_2 = 1.65 \pm 0.49$ cm^{-1}, is deduced. Previous results from measurements of the diffusion parameters of Santowax-R as functions of the temperature are presented. To calibrate the experimental set-up used, measurements were performed in which Gilotherm substitutes Santowax-R. With regard to non-multiplying media, measurements are in progress to study the effect produced by a reflector on the mean life of neutrons in moderators. In order to apply the pulsed neutron source technique to multiplying media, a 150-kv pulsed accelerator was built. The first measurements will be performed on a heavy water-moderated subcritical assembly and with two different kinds of fuel elements: uranium oxide and uranium carbide organic-cooled fuel elements. The measurements will be performed at ambient temperature. (auth)

38044 (A/CONF.28/P/680) INVESTIGATIONS OF THE MODERATING PROPERTIES OF WATER. U. Dahlborg (Sweden. Kungliga Tekniska Högskolan, Stockholm), G. Grosshoeg, K. E. Larsson, E. Moeller, S. N. Purohit, and N. G. Sjoestrand. May 1964. 15p.

A review is given of the work performed to investigate the moderating properties of water by various experimental and theoretical methods. Using slow neutron time-of-flight spectrometers the nature of atomic motions in light and heavy water was investigated, in the case of light water in the temperature range from −3 to +95°C and in the case of heavy water from −10° to +300°C. Generalized frequency distributions were derived from the experimentally determined inelastically scattered neutron spectra and found to exist even at +300°C. This fact as well as the width of the quasi-elastic peak indicates a clear solid-like behavior of the water molecules. It is shown that the continuous diffusion model does not explain the width behavior and that the gas model does not describe the translational motions of the water molecules. It is found that the quasi-elastic peak is to a high degree determined by the motion of the protons in the hydrogen bonds. (auth)

38045 (A/CONF.28/P/681) A METHOD FOR CALCULATING COLLISION PROBABILITIES IN GENERAL CYLINDRICAL GEOMETRY AND APPLICATIONS TO FLUX DISTRIBUTIONS AND DANCOFF FACTORS. Ingvar Carlvik (Aktiebolaget Atomenergi, Stockholm). May 1964. 15p.

Fundamental equations for cylindrical geometry are applied to cells with annular geometry and to cells containing a central rod cluster. The necessary integrations are performed in a way different from the one commonly used, in order to shorten the numerical work. Particularly for the annular geometry, it is possible to arrange the integration in such a way that an efficient Gauss integration can be performed. The Gauss constants are chosen with regard to the known irregularities of the integrand, with different possible sets of constants being investigated. Moments of the first flight distance can be calculated in much the same way as the collision probabilities for neutrons originating in each region. This makes it possible to calculate the axial and radial diffusion areas for a given source distribution when the flux distribution is solved. This theory is also presented. This work has lead to several computer programs, and results from calculations are reported. Since the problem under investigation is the transport of

neutrons, only one energy group problem was investigated so far. However, there is no objection to the use of these methods in many-group calculations. Only a white boundary condition was used at the cell boundary. The collision probability matrix is calculated for a black cell boundary, and the white boundary matrix is obtained by a simple adjustment. A closely related problem would be the calculation of Dancoff factors. In the case of annular geometry, Dancoff factors can be obtained directly from collision probabilities. Dancoff factors can be obtained in the same way for cluster geometry, but it would be more suitable to use a special computer program. A theory is presented for the calculation of Dancoff factors in cluster geometry, and tables of results are given for the ordinary 7-, 19-, and 37-rod cluster. (auth)

38046 (A/CONF.28/P/688) PENETRATION OF NEUTRONS IN CYLINDRICAL AIR DUCTS IN DIFFUSING MEDIA. A. Etemad and J. M. Pictet (Switzerland. Eidgenossisches Institut fur Reaktorforschung, Würenlingen). May 1964. 20p.

An attempt is made to fill the gap between simple methods of thermal flux evaluation in straight ducts giving generally poor results and prohibitively time consuming Monte Carlo calculations. A method for the determination of the thermal neutron flux in a duct, due to neutrons of all energies emitted by a plane source perpendicular to the axis of the duct is elaborated. (auth)

38047 (A/CONF.28/P/708) ANGULAR LEAKAGE SPECTRUM OF THERMAL NEUTRONS. R. Kladnik (Nuklearni Institut "Josef Stefan," Ljubljana, Yugoslavia). May 1964. 20p.

A review of the variational-iterational method of solving the integral transport equation for thermal neutrons in a semi-infinite source-free absorbing medium is given. This method is used to obtain explicit expressions for the linear extrapolation distance and leakage flux of thermal neutrons in terms of the corresponding infinite medium solution. For illustration, a classical monatomic gaseous moderator was chosen for which the infinite medium solution was already obtained semi-analytically. The absorption cross section is supposed to follow the 1/v law. The numerical part of the problem was solved on the IBM 704 digital computer. Numerical results for the linear extrapolation distance for different atomic mass numbers with several degrees of the absorption probabilities of the medium are presented. Also, the effective temperature of leaking neutrons is discussed as a function of the atomic mass, the absorption of the medium, and for different directions of neutron leakage. Theoretical results are discussed in comparison with the experimental values. (auth)

38048 (A/CONF.28/P/762) ON THE EXPERIMENTAL REGION CONNECTING DIFFUSION LENGTH AND PULSED NEUTRON EXPERIMENTS. K.-H. Joest and G. Memmert (Internationale Atomreaktorbau G.m.b.H., Bensberg, Germany). May 1964. 12p.

According to a remark of H. C. Honeck there is a gap between the area of pulsed neutron measurements and stationary diffusion length measurements, if they are described in the plane of $\lambda - \nu\Sigma_A$ vs. B^2. This is due to the fact that there is no absorption possible which is smaller than that of the moderator itself. If one considers the possibility of exponential experiments with sources rising with time or falling not faster than exp- $\nu\Sigma_A \cdot t$ full analogy between the B^2 and $x = -B^2$ region can be established without any gap. The exponential time variation of the flux impressed by the time variation of the source is physically equivalent to a change in the absorption of the system. Especially the decaying state corresponds to a depoisoning so that states with effective absorption smaller than $\nu\Sigma_A$ can be realized, which are impossible in the stationary diffusion length measurements. The increase in poisoning could be simulated by sources increasing exponentially in time. If an exponential source could be realized experimentally with sufficient accuracy, such experiments may be faster and cheaper than the stationary poison variation experiments. The theory of asymptotic states of the form exp- $\{\lambda t - xZ\}$ was treated for the monoenergetic and the energy dependent Boltzmann equation. The states exp- $\{\lambda t + 1BZ\}$, corresponding to pulsed experiments in finite media, were included in the analysis in order to show the strong relations between the two types of asymptotic theories. (auth)

38049 (A/CONF.28/P/827) GENERALIZATION OF THE FERMI AGE THEORY AND ITS APPLICATION TO THE CALCULATION OF RESONANCE ESCAPE PROBABILITY. G. Rakavy and J. J. Wagschal (Hebrew Univ., Jerusalem). May 1964. 6p.

The Fermi age theory is generalized by replacing the Fermi expression for the slowing-down density (q) with a differential expression (expansion) obtained by expanding the collision density in the exact expression for q in a series and integrating term by term. The first term of the expansion is the Fermi expression for q. A two-term approximation, however, gives more accurate results in resonance escape probability calculations. The differential expression also improves diffusion or transport calculations. (D.C.W.)

38050 (A/CONF.28/P/842) GENERALIZED POTENTIAL THEORY FOR MULTIGROUP DIFFUSION IN A GENERAL MULTIREGION REACTOR. H. Koskinen (Finland. Teknillinen Korkeakoulu, Otaniemi). May 1964. 16p.

The mathematical background is given for a new approach to the multigroup diffusion equations in general geometries, in many respects analogous to the classical potential theory. The partial differential equations describing the static or kinetic behavior of a multiregion reactor in diffusion approximation can be transformed into a system of linear integral equations for the surface fluxes and for the normal derivatives of the fluxes at the surfaces. If the interfaces include corners, concentrated sources, or other singularities, the role of the normal derivative will be played by an additive set function, from which arises a Radon-measure in the corresponding integral equations. The singular Green functions and their derivatives normal to the surfaces appear as kernels in the equations. (auth)

38051 (KAPL-M-6145) SWAK — A THERMAL CROSS SECTION PROGRAM. F. D. Federighi and T. J. Reno, Jr. (Knolls Atomic Power Lab., Schenectady, N. Y.). Apr. 15, 1964. Contract W-31-109-eng-52. 62p.

SWAK computes one-group macroscopic cross sections and diffusion parameters for thermal energies. Blackness coefficients and mixed number density constants are also computed. The scattering kernel is expressed as an $N \times N$ matrix with absorption and leakage terms included; the flux is obtained by direct inversion of the resulting matrix. The program was written for a Philco 2000 with a 32K core and 4 tape units; the source language was FORTRAN. (R.E.U.)

38052 (KAPL-M-6158) SUGGESTED PROCEDURES FOR UTILIZING MUFT RESONANCE PARAMETERS TO INCLUDE DOPPLER BROADENING. D. T. Goldman (Knolls Atomic Power Lab., Schenectady, N. Y.). June 1, 1964. Contract W-31-109-eng-52. 14p.

Keeping within the MUFT framework, a method is pro-

posed for including the effect of Doppler (temperature) broadening of resonances on the calculation of resonance integrals. This method is seen to be simple in its application. Some attempt has been made to determine its range of validity especially in comparison with the technique presently in use in MUFT. An additional proposal is made to replace for all nuclei the NRIA approximation presently in use in MUFT with the NR approximation. (auth)

38053 (NAA-SR-Memo-9427) ABSORPTION CROSS SECTION IN AGOT GRAPHITE. T. E. Stewart (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 7, 1964. Contract [AT(11-1)-Gen-8]. 35p.

Measurements were made in the 8 ft × 12-ft-dia. SGR assembly to determine the effective thermal neutron absorption cross section and the thermal neutron diffusion length in AGOT-type graphite. The absorption cross section was determined by comparing the volume-integrated thermal flux distribution measured in carbon to that measured in water using the same source of neutrons. The thermal neutron diffusion length was determined from the flux distributions obtained at distances greater than 60 cm from the neutron source. (auth)

38054 (NAA-SR-Memo-9500) MODIFICATIONS TO THE RBU MONTE CARLO NEUTRON AGE CODE. Leo B. Levitt (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 1964. Contract AT-11-1-GEN-8. 17p.

Agreement was obtained between infinite homogeneous medium age in water calculations performed by the RBU Monte Carlo age code and the TYCHE code. Modifications were performed both in the Monte Carlo portion of RBU and in its cross section energy grid structure to achieve this. Reduction in running time of RBU for age calculations possibly greater than a factor of 10 has been obtained by the modification of the Monte Carlo reaction selection procedure in RBU. (auth)

38055 (TID-20943) CALCULATION OF CROSS SECTIONS FOR REACTOR DESIGN. Norman C. Francis (Knolls Atomic Power Lab., Schenectady, N. Y.). Aug. 1964. Contract [W-31-109-eng-52]. 18p.

Theoretical considerations in calculations of cross sections for reactor design using the optical model are discussed. (R.E.U.)

38056 (AEC-tr-6398(p.126-38)) THERMALIZATION OF NEUTRONS (SURVEY REPORT). M. V. Karzarnovskii and A. V. Stepanov. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 107-?(1961).

The effects of the chemical bond and thermal motion of atoms on neutron transport in matter at energies below 1 ev are discussed; this has been given the name of neutron thermalization. A general description of the processes involved is presented. (R.E.U.)

38057 SOME NEUTRON TRANSPORT PROBLEMS. Antoni Kuszell. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 289-92(1961). (In Russian)

A review is presented of neutron transport studies. In some, the problem of the single-velocity Boltzmann equation was examined from the point of view of the isotropic neutron scattering in flat geometry; the derived equations indicated that part of the discrete spectrum may have a diffusion solution. In other studies the Boltzmann equation was applied to more general cases. Several involved solution of the critical problem for an infinite slab, developing an approximation method for the final equations. The boundary conditions define the equation for the distribution coefficients. By making use of the singular integral equation, the above leads to a single Fredholm-type integral equation, an approximate solution of which was obtained by using the Neumann series method. At zero approximation a diffusion solution is obtained; the results were found to agree with those obtained by the usual methods based on the extrapolation length. Other studies are discussed in which the albedo and the critical problems of more complex systems were investigated, including that of a reactor with infinit and finite reflectors and of a three-region reactor with an infinite reflector. In all cases, the solution leads to a singular integral, Fredholm-type equation with one additional critical condition. The Boltzmann equation was also solved for cases of isotropic neutron scattering in the n-group approximation of the energy dependence. (TTT)

38058 SOME PROBLEMS CONCERNING THE THEORY OF PULSED NEUTRON EXPERIMENTS. Gy. Kosaly, P. Vertes, and Z. Weiss (Inst. of Nuclear Research, Warsaw). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 489-99(1961).

The energy-dependent treatment and the transport theory approach to problems in pulsed neutron experiments are worked out. Basic problems involved in determination of the eigenvalues which can be solved without the use of an actual collision model are considered. (T.R.H.)

38059 ON THE THEORY OF THE PILE OSCILLATOR METHOD FOR DETERMINING THE CROSS-SECTIONS OF NEUTRON-NUCLEUS INTERACTION. I. I. Purica. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 501-17 (1961).

An analysis is made of the correlation existing between the characteristics of the neutron flux oscillation in a reactor, and the nuclear characteristics of the sample submitted to oscillation. The object of the analysis is a correct interpretation of experimental data and the establishment of maximum sensibility when the oscillation region has characteristics different from those of the reactor lattice. (T.R.H.)

38060 MEASUREMENT OF NEUTRON DIFFUSION PARAMETERS USING NEUTRON WAVES. Glen Albert Mortensen. Thesis, Berkeley, Calif., Univ. of California, 1963. 201p.

The theory of neutron wave propagation in homogeneous media was developed using the one-energy group, P_1 approximation. Both non-multiplying and multiplying media were investigated. In the latter case, one group of delayed neutrons was included in the analysis. The theory was extended to include the one-energy group, P_n approximation and the multigroup, P_1 approximation using matrix solution methods. A correspondence was established between the one-energy group, P_1 approximation and the two-line transmission line equations. In this correspondence, neutron flux corresponds to voltage and neutron current to electrical current. The analogy enables the solution of several neutron transport problems by transposing the corresponding transmission line solution. Neutron wave behavior, using the one-energy group, P_1 approximation, was investigated in heterogeneous systems. First, the refraction and reflection of plane waves on plane boundaries were considered. The theory was next specialized to slab lattice systems in which the wave was moving either parallel or perpendicular to the face of the slabs. The two component system of graphite and paraffin was investigated experimentally using a neutron wave generator and detection equipment. The heterogeneous slab lattice consisted of eight-inch-thick slabs of graphite alternating with five-

eighths-inch-thick slabs of paraffin. The results of the neutron wave measurements made in both the parallel and perpendicular directions in this lattice compared reasonably well with the theoretical predictions based on the one-energy group, P_1 approximation. It was concluded that an improvement in comparison of the measured values with the theoretical values could be obtained by using a multigroup P_1 model and a stronger neutron source. (Dissertation Abstr., 24: No. 12, Pt. I (June 1964))

Nuclear Properties and Reactions

Refer also to abstracts 37535, 37741, 37826, and 38610.

38061 (A/CONF.28/P/13) STUDIES OF THE FISSION PROCESS INDUCED BY THERMAL NEUTRONS. J. S. Fraser and J. C. D. Milton (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.). May 1964. 10p.

The mass and kinetic-energy distributions in the thermal-neutron fission of ^{239}Pu, ^{233}U, and ^{235}U were investigated using time-of-flight techniques to measure simultaneously the velocities of the fragment pairs. The neutron yields from individual fragments were also measured. A fine structure was observed in the mass yields. The large decrease (35 Mev) in the total kinetic energy for nearly symmetric mass division was confirmed and was shown to be connected with an increase in the total yield of prompt neutrons. (D.C.W.)

38062 (A/CONF.28/P/377) NEW RESULTS OF SHIELDING RESEARCH. O. I. Leypunskii, S. G. Tsypin, A. A. Abagyan, et al. (U.S.S.R.). May 1964. 18p.

The physics of shielding covers the investigations of radiation fields, migration of radioisotopes, and the physical standardization of the biological effects of radiation. The knowledge of radiation fields is of special importance. The development of research techniques requires new experimental facilities and new theoretical approaches. New equipment for carrying out research in the field of shielding is mentioned. Many problems connected with the gamma-ray and neutron fields have been solved in recent years. A prominent place is held in these investigations by a method whereby the field of an elementary radiation source is investigated first, and then the field of a real source is treated as a superposition of the fields from the elementary sources. For a long time an elementary source was taken to be a point isotropic source. However, a point monodirectional source (narrow ray) is a more elementary source, which can be used to form all sources treated before (isotropic point, isotropic plane, and anisotropic sources). Results are presented of the experimental study of the fields from monodirectional point sources in various media and the empirical formulas which describe the results of the experiments. A useful contribution to the calculation of the field of a monodirectional point source can be made by the use of adjoint functions for solving the kinetic equation of the transfer of γ-quanta. Calculation of the shielding is connected with the evaluation of the biological effect of penetrating radiation. Hence the necessity for more accuracy in determining the spectrum of neutrons coming through the shielding and for evaluation of the radiation dose from intermediate-energy neutrons. A dose storage factor was introduced to describe the doses. This dose storage factor was calculated for various compositions and various arrangement of the reactor shielding layers. An extensive use of reactors pose an important problem of shield optimization. Convenient methods for solving this problem are still being sought. One such method is the introduction of the function effectiveness of the shielding material versus specific process. The mathematical methods of treating this function, particularly perturbation theory methods make it possible to find the conditions for the optimal composition of the shielding. (auth)

38063 (A/CONF.28/P/583) NEW ISOTOPES AND SYSTEMATICS OF NUCLIDES. I. Selinov (U.S.S.R.). May 1964. 21p.

The rational systematization of nuclides reflects the regularities of atom nucleus structure, systemizes the isotope properties, and facilitates new isotope search. The determination of a number of periodical regularities in masses, mass numbers, abundance, and other properties of isotopes makes possible the plotting of the atomic nucleus periodic system (on the basis of the shell model). The helionic type of building 2 β-stable nuclides and the analogic isotope concept are described. The proposed atomic nuclei system is described. The principal identity of different forms of the nuclide system which depict the same regularities in atomic nuclei plotting is shown. Stable isotope mass numbers are predicted in the old variant of the periodic system of isotopes. Radioactive nuclides are systemized, and mass numbers of stable isotopes of transuranium elements are predicted. The regularities in half lives comprise the basis of search for new isotopes. The possibility of discovery of new isotopes useful as radiotracers and in geological age determination is shown. The possibility of use of some new fissionable isotopes as compact neutron sources particularly for activation analysis is described. (auth)

38064 (A/CONF.28/P/717) SURVEY OF NUCLEAR DATA FOR REACTOR CALCULATIONS. C. H. Westcott (International Atomic Energy Agency, Vienna), K. Ekberg, G. C. Hanna, N. J. Pattenden, and S. Sanatani. May 1964. 18p.

The extent to which further increases of detail or accuracy in nuclear data are still needed is considered. A few quantities were selected for attention to illustrate the problem, in particular the thermal neutron constants for the fissile nuclei of U and Pu. (auth)

38065 (A/CONF.28/P/792) GAMMA ENERGY RELEASE RATES FROM FISSION PRODUCTS AT SHORT TIMES AFTER FISSION. M. Ramakrishna Iyer and A. K. Ganguly (India. Atomic Energy Establishment, Trombay). May 1964. 19p.

The gamma energy release rates and photon emission rates from fission product mixtures formed from the instantaneous fission of ^{235}U were computed. The data on fission yields, half lives and gamma decay energies were taken from the latest compilation (complete up to June 1962) of the nuclear properties of ^{235}U fission products. The gamma spectrum is presented by dividing the fission product gamma energies into ten groups on the basis of their weighted average energies and weighted average air dose characteristics. The variation of gamma energy release rates, photon emission rates, and weighted average energy in each group, and in the total fission products were studied. The results are plotted for decay times ranging from 10^{-1} to 10^5 seconds. The gamma energy release rates presented are found to be a significant improvement over the existing computed values at cooling times less than 1000 seconds. Above 1000 seconds the values agree with the computed values obtained by earlier workers. An experimental technique was developed to estimate the time dependence of gamma energy release rates at times of cooling in the region of milliseconds and onwards. (auth)

38066 (AWRE-O-37/64) NEUTRON CROSS SECTIONS OF U-234 IN THE ENERGY RANGE 1 kev–15 Mev. K. Parker (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). July 1964. 49p.

Recommended values are given for neutron total and partial cross sections of ^{234}U in the energy range 1 kev to 15 Mev. The available experimental evidence is supplemented by estimates based on nuclear systematics. Details of energy and angular distributions are given so that the data are complete for the purposes of neutronics calculations. The values given are available on punched cards as part of the UKAEA Nuclear Data Library. Literature references to data at neutron energies below 1 kev are given so that the data can be extended to lower energies at some later date. (auth)

38067 (AWRE-O-61/64) NEUTRON CROSS SECTION OF Li-7 IN THE ENERGY RANGE 0.001 eV–15 Mev. E. D. Pendlebury (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). July 1964. 74p.

Recommended values are given for neutron total and partial cross sections of ^{7}Li in the energy range 0.001 ev to 15 Mev. The available experimental data are supplemented where necessary by estimates based on nuclear theory. Details of energy and angular distributions are given so that the data are complete for the purposes of neutronics calculations. (auth)

38068 (KAPL-M-6157) MUFT/KATE CROSS SECTION CONVERSION TO DRAM LIBRARY FORMAT. C. R. Lubitz and M. G. Fuda (Knolls Atomic Power Lab., Schenectady, N. Y.). May 1964. Contract W-31-109-eng-52. 39p.

Procedures and formulas for the construction of neutron cross section libraries for the Monte Carlo transport program DRAM are described. In this work the sources of the data were the libraries for the epithermal slowing-down code MUFT and the thermal spectrum code KATE. These libraries are described in some detail to facilitate future inter-library conversions of this type. (auth)

38069 (NP-14111) ÉTUDE DE LA RÉACTION $^{28}Si(n,\alpha)^{25}Mg$ INDUITE PAR DES NEUTRONS DE 14.55 Mev (thèse). (Studies of the $^{28}Si(n,\alpha)^{25}Mg$ Reaction Induced by 14.55-Mev Neutrons (thesis)). Danielle Devillers (Toulouse, France. Université). [1962]. 77p.

The experimental apparatus for the study of the $^{28}Si(n,\alpha)^{25}Mg$ reaction at 14.55 Mev consisted of a P-N silicon junction target-detector. In order to reduce the effect of the protons created simultaneously by the (n,p) reaction, the detector thickness was limited, which has the inconvenience of increasing the distortions caused by boundary effects. A complete calculation of these distortions was made, and the diffusion zone and the barrier of the detector were considered at the same time. This calculation gave a correction to these distortions even when the particle path was of the order of magnitude of the thickness of the detector barrier. This method allowed a determination of the position of the different alpha peaks between 3 and 11.55 Mev, corresponding to excited levels of ^{25}Mg between 0 and 8.5 Mev. The experimental curves show the variation of the differential cross section for the first six excited states of ^{25}Mg (between 0 and 2.6 Mev). (tr-auth)

38070 (NP-14171) MESURE DE VIES MOYENNES D'ETATS NUCLEAIRES EXCITES DANS LE DOMAINE DE LA NANOSECONDE (theses). (Measurement of Mean Lives of Excited Nuclear States in the Nanosecond Region (thesis)). Robert Rougny (Lyon. Université). July 10, 1964. 86p.

The probabilities for γ transition and the different methods used to measure short life times (10^{-6} to 10^{-12} sec) were reviewed. The time-amplitude conversion technique used in the study and the various methods of processing the experimental information were described. The experimental setup, its characteristics, and its possibilities are discussed. The life-time of the first excited levels of ^{170}Yb, ^{207}Pb, ^{203}Tl, ^{186}Os, and ^{182}W, and the 1290-kev level of ^{182}W were measured. The values obtained were: ^{170}Yb excited level at 84 kev, $T = 1.56 \pm 0.05 \times 10^{-9}$; ^{186}Os at 137 kev, $T = 0.845 \pm 0.02 \times 10^{-9}$; ^{203}Tl at 279 kev, $T = 0.283 \pm 0.007 \times 10^{-9}$; ^{182}W at 1200 kev, $T = 1.04 \pm 0.03 \times 10^{-9}$; ^{182}W at 100 kev, $T = 1.47 \pm 0.09 \times 10^{-9}$; and ^{207}Pb at 570 kev, $T = 1.4 \pm 0.12 \times 10^{-9}$ sec. (J.S.R.)

38071 (NP-14214) AN EXPERIMENTAL STUDY OF RADIATIVE FAST NEUTRON CAPTURE. Ingvar Bergqvist (Lund, Sweden. Univ.). 1963. 10p.

Gamma spectra from fast-neutron capture in various materials were studied. A listing of published papers is given. (R.E.U.)

38072 (UCRL-7676) THE POLARIZATION OF NEUTRONS FROM THE $C^{13}(p,n_0)N^{13}$ AND $N^{15}(p,n_0)O^{15}$ REACTIONS (thesis). Bryan Dale Walker (California. Univ., Livermore. Lawrence Radiation Lab.). June 1, 1964. Contract W-7405-eng-48. 59p.

The polarizations of neutrons from the $^{13}C(p,n_0)^{13}N$ and $^{15}N(p,n_0)^{15}O$ reactions were measured for several proton energies in the region between 6.9 and 12.3 Mev and neutron emission angles between 0 and 90°. The neutrons were detected using the Livermore time-of-flight facility incorporating pulse-shape discrimination to reduce the time-independent background. The "left" and "right" measurements were obtained by employing a solenoid for spin precession. Liquid helium was utilized as an analyzer. Large polarizations (50 to 70%) were noted for both reactions at several energies and angles. Corrections for multiple scattering in the analyzer were made. The energy dependence of the polarizations tends to confirm the "twin" reaction hypothesis of Bloom, et al. Comparisons with polarization predictions of the quasi-elastic model of the (p,n) process are also shown. (auth)

38073 (AEC-tr-6398(p.59-63)) EFFECTIVE FISSION CROSS SECTIONS OF Th^{229}, Th^{230}, AND Np^{237}, AND ANISOTROPIC FISSION CROSS SECTIONS OF Th^{230} AND Np^{237}. B. M. Gokhberg, G. A. Otroshchenko, and V. A. Shigin. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 57-?(1961).

The fission isotropy was studied for thermal and epithermal neutron fissions of ^{229}Th, ^{230}Th, and ^{237}Np. (R.E.U.)

38074 (AEC-tr-6398(p.64-9)) ELASTIC SCATTERING OF 400-kev NEUTRONS ON Zn, Se, Zr, Nb, Mo, Cd, In, AND Sn. E. A. Koltypin and G. B. Yan'kov. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 61-?(1961).

The optical nuclear model was used to correlate theoretical and experimental data for neutron elastic scattering at 400 kev by Cd, In, Mo, Nb, Se, Sn, Zn, and Zr. Differential cross sections are shown. (R.E.U.)

38075 (AEC-tr-6398(p.70-80)) MEASUREMENTS OF THE ENERGY DEPENDENCE OF RADIATION NEUTRON CAPTURE IN THE ENERGY REGION UP TO 30 kev. A. I. Isakov, Yu. P. Popov, and F. L. Shapiro. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz, SSR, 1: 64-?(1961).

Measurements of the energy dependence of the radiative-capture cross sections for neutrons in Cl, Fe, Ag, and Au were performed in a spectrometer during neutron slowing-down in a lead cube; preliminary data are given for Rh, Cu, and Ni. A scintillation counter was used to register the capture-gammas in the center of the lead cube. (R.E.U.)

38076 (AEC-tr-6398(p.90-6)) (d,t) REACTIONS ON THE NUCLEI C^{12}, F^{19}, AND Al^{27}. N. A. Vlasov, S. P. Kalinin, A. A. Ogloblin, and V. I. Chuev. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 79-?(1961).

The spectra of tritons from (d,t) capture reactions on ^{27}Al, ^{12}C, and ^{19}F were studied to determine the probability of excitation with increasing energy of the level of the final nucleus. (R.E.U.)

38077 (AEC-tr-6398(p.97-102)) INVESTIGATION OF THE INTERACTION OF ALPHA PARTICLES WITH LITHIUM NUCLEI. K. V. Makaryunas. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 85-?(1961).

Interaction mechanisms were studied for various alpha reactions at 10 to 15 Mev with ^6Li and ^7Li. Thick-layer nuclear emulsion techniques were used to study angular distributions from the reactions (α,α'), (α,d), (α,t), and (α,p). (R.E.U.)

38078 (AEC-tr-6398(p.103-12)) ENERGY DEPENDENCE OF THE ANGULAR DISTRIBUTIONS OF $B^{10}(d,p)B^{11}$ REACTIONS. S. V. Starodubtsev and B. I. Khrushchev. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 89-?(1961).

Angular distributions from $^{10}B(d,p)$ reactions were studied to determine parity and spin of levels of ^{11}B. (R.E.U.)

38079 (AEC-tr-6398(p.113-19)) ELASTIC AND INELASTIC SCATTERING OF 13.2-Mev ALPHA PARTICLES ON LITHIUM AND THE REACTIONS $Li^6(\alpha,p)Be^9$ AND $Li^7(\alpha,p)Be^{10}$. S. V. Starodubtsev and K. V. Makaryunas. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 98-?(1961).

Nuclear reaction mechanisms were investigated in alpha reactions with ^6Li and ^7Li at 13.2 Mev. Angular distributions were studied. (R.E.U.)

38080 (AEC-tr-6398(p.120-5)) SCATTERING OF MEDIUM-ENERGY NUCLEONS AND THE OPTICAL MODEL OF THE NUCLEUS. M. V. Pasechnik, N. N. Pucherov, I. A. Totskii, and V. I. Chirko. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 103-?(1961).

Angular distributions of elastically scattered protons and neutrons at 6.8 and 2.8 Mev, respectively, were studied for Bi, Pb, Sn, Cd, Ag, Zn, Cu, Ni, Co, Fe, and Al. Contributions of elastic-scattering studies to the nuclear optical model are discussed. (R.E.U.)

38081 (AEC-tr-6398(p.139-52)) MECHANISM OF THE EMISSION OF NUCLEAR FRAGMENTS. E. P. Denisov, K. V. Kosareva, and P. A. Cherenkov. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 117-?(1961).

Fragmentation mechanisms for the emission of light nuclei ($Z \geq 3$) in interactions of high-energy particles with nuclei are discussed. A cascade mechanism is proposed. (R.E.U.)

38082 (AEC-tr-6398(p.153-6)) INVESTIGATION OF EXCITED FRAGMENTS. S. A. Azimov, U. G. Gulyamov, R. Karimova, and B. G. Rakhimbaev. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 126-?(1961).

The decomposition of excited fragments produced in Ilford G-5 emulsion stacks by π mesons at 4.5 Bev was studied. The masses of the decomposition products were determined. (R.E.U.)

38083 (AEC-tr-6398(p.157-63)) INVESTIGATION OF CAPTURE REACTIONS ON LIGHT NUCLEI AT NEUTRON ENERGIES OF 14.1 Mev. G. E. Velyukhov, A. N. Prokof'ev, and S. V. Starodubtsev. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 129-?(1961).

Experimental studies of the reaction (n,d) with ^{19}F, ^{31}P, and $^{32,34}S$ at 14.1 Mev were performed. A telescope, consisting of two proportional and scintillation counters, was used to identify and measure the deuteron groups. (R.E.U.)

38084 (AEC-tr-6398(p.164-88)) INVESTIGATION OF THE PHOTOFISSION OF NITROGEN, OXYGEN, AND NEON. A. G. Gerasimov, A. N. Gorbunov, V. A. Dubrovina, et al. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 134-?(1961).

A Wilson chamber in a magnetic field acting directly in the beam of 170-Mev bremsstrahlung was used to study photonuclear reactions on ^{14}N, ^{16}O, and ^{20}Ne. (R.E.U.)

38085 (AEC-tr-6398(p.288-95)) MASS SPECTROMETRIC DETERMINATION OF THE YIELD OF FISSION FRAGMENTS OF HEAVY NUCLEI AND PRODUCTS OF CERTAIN OTHER NUCLEAR REACTIONS. L. Krizhanskiĭ. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 222-?(1961).

Mass spectrometric methods of nuclear investigation are discussed. Fragment yields for fissions of ^{239}Pu were determined; isotopes of Cs, Nd, Sm, Sr, Ba, and Ce were determined. (R.E.U.)

38086 (AEC-tr-6398(p.338-41)) SPECTRA OF CONVERSION ELECTRONS OF THE NEUTRON-DEFICIENT ISOTOPES OF THULIUM. A. A. Abdurazakov, K. Ya. Gromov, B. S. Dzhelepov, G. Ya. Umarov, and I. A. Yutlandov. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 259-?(1961).

Procedures and results of identification of the lines in the conversion electron spectra of thulium isotopes are presented. (R.E.U.)

38087 (AEC-tr-6398(p.342-9)) ANGULAR DISTRIBUTION OF PROTONS FROM THE $C^{12}(\alpha,p)N^{15}$ REACTION AT AN ALPHA PARTICLE ENERGY OF 14.5 Mev. M. P. Konstantinova, E. V. Myakinin, A. M. Romanov, and T. V. Tsareva. Translated from Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 262-?(1961).

Results in the form of histograms are presented for angular distributions from the reaction (α,p) with carbon-12 at 14.5 Mev. (R.E.U.)

38088 SLOW-NEUTRON CROSS SECTIONS OF HAFNIUM. Masao Atoji (Argonne National Lab., Ill.). Acta Cryst., 17: 1087-8(Aug. 20, 1964).

The slow-neutron scattering and related cross sections of Hf pertinent to neutron diffraction study were investigated. The cross sections of naturally occurring Hf at 293 ± 3°K were reexamined at 0.0717 ± 0.0002 ev (λ = 1.068 ± 0.002 A) and some at 0.0460 ev (λ = 1.333 A) using a neutron diffractometer. The coherent scattering cross section of Hf (13.2 barns for Ni) was found to be 7.59 ± 0.27 barns at 0.0717 and 0.460 ev. The sign of the ampli-

tude, $b = 0.777 \pm 0.014 \times 10^{-12}$, was reconfirmed to be positive from the $HfC_{0.95}$ data. Debye thermal elastic incoherent scattering, and the sum of all other scattering are, respectively, 75.3 ± 0.2, 5.77, 1.61, and approximately 4.0 barns. It was concluded that the imaginary part of the scattering amplitude of natural Hf can be neglected in diffraction studies at subcadmium neutron energies. (P.C.H.)

38089 TRIPLE COINCIDENCE AND CORRELATION MEASUREMENTS OF GAMMA RAYS FROM Pb^{208}. E. Spring (Univ. of Helsinki). Acta Polytech. Scand., Phys. Nucl. Ser., No. 32, 1-22(1964).

Gamma transitions in ^{208}Pb were investigated by double and triple coincidence measurements. Two new transitions, 0.275 and 0.552 Mev, starting from the 3.750-Mev level, were established. The spin of the 3709-kev level is either 4^- ($\delta \approx +0.35$) or 5^- ($\delta \approx -0.15$) according to the measurements of double and triple angular correlations. δ is the multipole mixing parameter of the 0.511-Mev gamma transition. (auth)

38090 SUCCESSION OF NUCLEAR ENERGY LEVELS FOR THE HOFSTADTER POTENTIAL DISTRIBUTION. G. T. Jeverdan. Analele Stiint. Univ. A. I. Cuza, Iasi, Sect I, 9: 271-5(1963). (In Rumanian)

The energy levels of the atomic nuclei were studied from the viewpoint of the nuclear shell theory, assuming that the levels possess a Hofstadter-type internal potential distribution. In agreement with the semiempirical Mayer-Jensen scheme, the existence of a spin-orbital coupling was also taken into account. The value of E_{He} was found to be -6.25×10^{-6} erg $\cong -4$ Mev. For the $1S^1/_2$ level of ^{40}Ca, $E \cong -1.4$ Mev; and for the $1P^3/_2$ level $E = -4.4$ Mev. (TTT)

38091 EFFECTS OF ACTIVE NUCLEONS ON THE DEUTERON STRIPPING PROCESS. H.-W. Barz (Zentralinstitut fur Kernphysik, Rossendorf, Ger.). Ann. Physik (7), 13: 164-73(June 1964). (In German)

The effects of the exchange elements of the distorted-wave Born approximation matrix on angular distributions from the reactions $^{13}C(d,n)^{14}N$ and $^{17}O(d,p_1)^{18}O$ were deduced. The procedure was to replace the distorted waves with regular waves with modified wave number. The suitabilities of two forms of the deuteron wave function were compared by studies of the knockout process $^{10}B(d,p_1)^{11}B$. Angular distributions below 60° show the exchange terms to shift the maximum toward smaller angles for $^{13}C(d,n)^{14}N$, and to increase the effective cross section for $^{17}O(d,p_1)^{18}O$ at small angles. (tr-auth)

38092 THE REDFIELD SEMI-CLASSICAL THEORY OF RELAXATION. H. Pfeifer (Karl-Marx-Universität, Leipzig). Ann. Physik (7), 13: 174-8(June 1964). (In German)

The relaxation of spin systems is discussed for Redfield's hypothesis using a time-dependent two-part hamiltonian in the semiclassical description. The statistical generality of identical spin systems is developed. (R.E.U.)

38093 THE LIFETIME OF THE 420-kev STATE IN Cd-111. P. Sparrman, T. Sundstroem, and J. O. Lindstroem (Uppsala Univ.). Arkiv Fysik, 26: 479-84(1964).

The half life of the 420-kev state in ^{111}Cd was measured to be 120 ± 30 psec using the delayed coincidence technique. The electromagnetic transition rates for the 173-kev transition are discussed and compared with the transition rates for other transitions in ^{111}Cd. (auth)

38094 THE $A^{38}(p,\gamma)K^{39}$ REACTION. S. E. Arnell and K. C. Tripathi (Chalmers Univ. of Tech., Goteborg). Arkiv Fysik, 26: 485-93(1964).

The $^{38}Ar(p,\gamma)^{39}K$ reaction was studied at 900 to 1400 kev, using an electromagnetically separated target. Eight resonances were found. From angular distribution measurements, tentative spin assignments to some low-lying excited states in ^{39}K were made. (auth)

38095 TRANSITIONS FOLLOWING THE DECAY OF Dy^{166}. V. Brabec, O. Bergman, Y. Grunditz, E. Aasa, and S. E. Karlsson (Uppsala Univ. and Inst. of Nuclear Research, Prague). Arkiv Fysik, 26: 511-19(1964).

Internal conversion and photoelectron measurements confirmed the existence of three transitions in ^{166}Ho which deexcite a state at 426 kev. The multipolarities of two of the transitions were found to be E1. In combination with the known ground state spin and parity, this unambiguously defines the state to have one unit of spin and even parity. A comparison of the relative transition probabilities with those predicted by the unified model shows that the 426-kev state is probably a member of a K = 0 rotational band. (auth)

38096 ATTENUATION OF THE ANGULAR CORRELATION IN LIQUID SOURCES. M. Salomon, R. Ballestero, and M. Zwanziger (Uppsala Univ.). Arkiv Fysik, 26: 521-6(1964).

The 173–247 kev gamma-gamma cascade in the decay of ^{111}In was measured by the differential angular correlation technique. The experimental attenuation coefficient was obtained using several liquid sources. Three different concentrations of glycerine in water were used, as well as pure acetic acid and a solution of dithizon. The experimental results are compared with the theory of Abragam and Pound and that of Dillenburg and Maris. (auth)

38097 CAPTURE AND INELASTIC SCATTERING OF PROTONS BY Ne^{21}. S. E. Arnell and E. Wernbom-Selin (Chalmers Univ. of Tech., Goteborg). Arkiv Fysik, 27: 1-16(1964).

An electromagnetically separated ^{21}Ne target was bombarded with protons in the energy range from 700 to 1300 kev. Several new resonances in ^{22}Na were found by (p,γ) and $(p,p'\gamma)$ reactions. The deexcitation of some of the resonances was studied. (auth)

38098 A SEARCH FOR POSITRON BRANCHING IN THE $Mn^{51}(\beta^+)Cr^{51}$ TRANSITION. S. E. Arnell and S. Sterner (Chalmers Univ. of Tech., Goteborg). Arkiv Fysik, 27: 33-9(1964).

From an investigation of the positron decay of ^{51}Mn, upper limits for positron branching to the 755- and 1167-kev states in ^{51}Cr were determined. (auth)

38099 GAMMA RAYS FROM PROTON BOMBARDMENT OF A^{40}. S. E. Arnell and P. O. Persson (Chalmers Univ. of Tech., Goteborg). Arkiv Fysik, 27: 41-59(1964).

The gamma branching of the resonances at $E_p = 1101$, 1108, and 1118 kev in the $^{40}Ar(p,\gamma)^{41}K$ reaction was studied by scintillation spectrometry. From direct spectra, coincidence spectra, and sum-coincidence spectra, the gamma branchings of the capturing states and several low-lying levels were determined. Previously unreported energy levels in ^{41}K are suggested at 3.45, 3.83, and 4.34 Mev. (auth)

38100 THE DECAY OF Rh^{105}. S.-E. Karlsson, O. Bergman, and W. Scheuer (Inst. of Physics, Uppsala and Comision Nacional de Energia Atomica, Buenos Aires). Arkiv Fysik, 27: 61-7(1964).

The beta decay of ^{105}Rh was studied using sources obtained by careful separation. Two beta branches with end point energies of 568 ± 4 and 249 ± 6 kev were found, together with conversion lines corresponding to transitions of 306.1 and 319.0 kev. The gamma intensities were measured in external conversion experiments with unseparated

sources. The energies of some transitions in the decay of ^{97}Ru and ^{103}Ru are given. (auth)

38101 LOW-ENERGY DEUTERONS AND TRITONS FROM THE PHOTOSPLITTING OF Li^6. A. P. Komar and E. D. Makhnovskii (Ioffe Inst. of Physics and Tech., Leningrad). Dokl. Akad. Nauk SSSR, 156: 774-7(June 1, 1964). (In Russian)

The energy spectra and yields of charged particles occurring on irradiation of ^{6}Li with bremsstrahlung radiation (E_γ(max) = 35 Mev) were investigated by means of thick-layered nuclear emulsions. A vacuum chamber placed in a homogeneous magnetic field (H = 13,500 Oe), which was approximately perpendicular to the direction of particle emission, was used in identifying the charged particles. The range and orientation of the tracks in the emulsion were used in identifying a particle. The data show that the triton yield from ^{6}Li is comparable to the proton yield. The ratio of deuteron yield to triton yield for particle energies from 1.2 to 4.8 Mev is $Y_d/Y_t = 0.25$. The occurrence of a significant number of low-energy deuterons can be explained only by a three-particle decay of ^{6}Li into a neutron, deuteron, and a ^{3}He nucleus, or into a proton, deuteron, and triton. The average deuteron energy is 2.7 Mev, and the maximum excitation should take place at E_γ = 29.8 Mev. The high triton yield is associated with a two-particle decay of ^{6}Li by means of a ^{6}Li(γ,t)^{3}He reaction. The maximum excitation function for this reaction lies at $E_\gamma \cong 21$ Mev, and the total cross section has a rather high value of 29 mb Mev. (TTT)

38102 THE EMISSION OF HELIUM PARTICLES DURING INTERACTION OF A HIGH-ENERGY PION OR NUCLEON WITH COMPLEX NUCLEI. Zh. S. Takibaev, G. Tlevbergenova, and E. V. Shalagina (Kazakh Government Univ., USSR). Dokl. Akad. Nauk SSSR, 156: 785-8 (June 1, 1964). (In Russian)

The emission of doubly charged helium particles with a kinetic energy $E_{kin} > 100$ Mev was investigated by irradiating a pile of Ilford G5 film plates in Geneva with 19.5-Bev protons and 17.5-Bev π mesons. Helium particles with $E_{kin} > 100$ Mev were found in 119 proton stars and in 240 π-meson stars. The reactions took place with heavy Ag and Br nuclei. The helium particles are emitted primarily in the forward hemisphere. The energy spectrum of the helium particles both with 9- and 19.5-Bev protons and also with 7.5- and 17.5-Bev pions can be represented by the following expression: $N(E)dE = \text{const. } E^{-2.6\pm0.4}dE$. The energy spectrum of the doubly charged particles does not depend on the energy of the bombarding particle within the limits of 10 to 20 Bev. With increasing energy of the primary proton, the cross section for the formation of helium particles with a kinetic energy > 100 Mev does not change, while in the case of π mesons, the cross section for the formation of doubly charged particles increases. (TTT)

38103 ENERGY LEVELS OF O^{16} IN THE VICINITY OF 13 Mev. I. V. Mitchell and T. R. Ophel (Australian National Univ., Canberra). Nucl. Phys., 58: 529-43(Sept. 1964).

Excitation functions and angular distributions for the gamma yield of the $^{12}C(\alpha,\gamma_0)^{16}O$ reaction were measured at α energies from 6.9 to 8.2 Mev. The data confirm previous evidence for a possible 2^+ state of ^{16}O at an excitation energy of about 13 Mev. Results of a concurrent investigation of the 4.43-Mev gamma yields from the $^{12}C(\alpha,\alpha'\gamma)^{12}C$ reaction indicate a possible 3^- level of ^{16}O at 13.13 Mev. (auth)

38104 PENETRATION EFFECTS IN THE K AND L INTERNAL CONVERSION COEFFICIENTS OF THE 279 kev TRANSITION IN Tl^{203}. C. J. Herrlander and R. L. Graham (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Phys., 58: 544-60(Sept. 1964).

The conversion lines of the 279.16 ± 0.02 and 401.27 ± 0.05 kev transitions in ^{203}Tl were studied. From the measured line intensities and the known total conversion coefficient (0.2262 ± 0.0019) measured by Taylor the conversion coefficients were obtained for the 279 kev M1 + E2 transition. The measured L conversion ratios of the 401-kev transition show that it is pure M1 with <2% E2, in accordance with earlier results. In order to test the accuracy of E2 theoretical L conversion coefficients, precise experimental line intensity ratios are reported for five pure E2 transitions in the region $76 \leq Z \leq 80$. The trend of these ratios when compared with theory indicates that the true L_{II} and L_{III} coefficients may be a few percent lower than Sliv's theoretical predictions. The experiments were performed in order to study the nuclear structure effect on the internal conversion of the M1 part of the 1 forbidden 279-kev transition. The significance of the K and L conversion coefficients is discussed in detail. They are consistent with a mixing ratio of $\delta^2 = E2/M1 = 1.4 \pm 0.2$ and a penetration parameter $\lambda = |M_2|/|M_1| \approx 7$ if Sliv's conversion coefficients and Church and Weneser's predictions for the behavior of β_{1K}, $\beta_{1_{II}}$, $\beta_{1_{II}}$ and $\beta_{1_{III}}$ as functions of λ for this transition are used. This value of λ is also consistent with the results of earlier experiments including those from γ-e^- angular correlation studies when reinterpreted using the above value for δ^2 and the alteration in sign of the particle parameter modifying the interference term which was pointed out recently by Geiger and Church. The effects of possible uncertainties in the present theoretical predictions are also considered and show that a solution with $\lambda \approx 73$ cannot be conclusively rejected although with present knowledge it seems unlikely. (auth)

38105 SEMI-EMPIRICAL FORMULA FOR NUCLEAR LEVEL DENSITY AND FISSION ASYMMETRY. N. N. Abdelmalek and V. S. Stavinsky (Atomic Energy Establishment, Cairo). Nucl. Phys., 58: 601-10(Sept. 1964).

It is noticed that residual interactions (pairing energy) influence not only the effective excitation energy values (counted from the characteristic level) but also the level density of single-particle states near the Fermi level. A semi-empirical formula for the single-particle level density is obtained on the basis of the experimentally observed order of filling of the single-particle level. Good agreement with experiment is obtained. The results obtained are used to explain the nuclear fission asymmetry from the statistical fission theory point of view. (auth)

38106 LEVELS IN La^{140} FROM THE BETA DECAY OF Ba^{140}. Y. K. Agarwal, C. V. K. Baba, and S. K. Bhattacherjee (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., 58: 641-50(Sept. 1964).

Some properties of the low-lying levels in ^{140}La as populated by the beta decay of ^{140}Ba were studied by beta-gamma and gamma-gamma directional correlation experiments. The multipole orders and the E2/M1 mixing ratios of the prominent gamma rays were thereby measured. On the basis of these measurements the following spin assignments to the ^{140}La levels have been made: 30 kev (2^-), 162 kev (2^-), 466 kev (1^-) and 566 kev (1^-). The 162-kev gamma ray is predominantly of E2 character with a reduced transition probability at least 90 times that of a single-particle transition. (auth)

38107 MEASUREMENT OF MAGNETIC MOMENTS OF EXCITED STATES IN Ta^{181} AND Cs^{133}. Y. K. Agarwal, C. V. K. Baba, and S. K. Bhattacherjee (Tata Inst. of Funda-

mental Research, Bombay). Nucl Phys., 58: 651-7(Sept. 1964).

The magnetic moments of the 482-kev ($^5/_2$) level in ^{181}Ta and the 80-kev ($^5/_2$) level in ^{133}Cs were measured by the azimuthal shift method. The results obtained are 3.23 ± 0.05 and 3.25 ± 0.15 nm, respectively. (auth)

38108 PULSED BEAM MEASUREMENT OF THE GYROMAGNETIC RATIO OF THE 100 kev 2^+ STATE IN TUNGSTEN-182. R. P. Scharenberg, J. D. Kurfess, G. Schilling, J. W. Tippie, and P. J. Wolfe (Case Inst. of Tech., Cleveland). Nucl. Phys., 58: 658-72(Sept. 1964).

The gyromagnetic ratio of the 100-kev 2^+ rotational state in ^{182}W was measured using the pulsed-beam technique. The precession of the Coulomb excited nuclei in an external magnetic field was detected by observing the deexcitation gamma radiation as a function of time. The value g = 0.239 ± 0.020 was obtained. The timing techniques which make possible an evaluation of the effect of target perturbations on the measurement are discussed. The mean life of the state was measured to be 1.98 ± 0.02 nsec, which is in agreement with other measurements. (auth)

38109 THE SCATTERING OF 12.0 Mev DEUTERONS BY THE SEPARATED ISOTOPES OF SILVER. H. F. Lutz, S. F. Eccles, and J. B. Mason (Univ. of California, Livermore). Nucl. Phys., 58: 673-7(Sept. 1964).

The scattering of 12.0-Mev deuterons by separated isotope targets of ^{107}Ag and ^{109}Ag was studied. The angular distributions show no diffraction pattern and are almost identical. Several optical potentials generate equally good fits to the data. (auth)

38110 HARTREE-FOCK METHODS FOR DEGENERATE CASES. Bernard Bremond (Faculté des Sciences, Orsay, France). Nucl. Phys., 58: 687-94(Sept. 1964).

A method giving a fully self-consistent minimization of a hamiltonian with respect to a sum of two Slater determinants is developed. A generalization of the Hartree-Fock method to be used in cases in which the usual Hartree-Fock method gives two solutions of comparable energies is obtained. The method is extended to the pairing case. The equations giving the eigenvalues of the energy of the small oscillations around equilibrium are then derived. (auth)

38111 THE STRUCTURE OF THE sd-SHELL NUCLEI. I. C^{18}, F^{18}, O^{19} AND Ne^{20}. T. Inoue (Nihon Univ., Tokyo), T. Sebe, H. Hagiwara, and A. Arima. Nucl. Phys., 59: 1-32(Oct. 1964).

A shell-model calculation for nuclei at the beginning of the 1s-0d shell was made taking into account the configuration mixing of the 1s and 0d shells. The position of the 1s level relative to the 0d level and the strength of the spin-orbit interaction were taken from the observed ^{17}O and ^{17}F spectra. A residual interaction was introduced and assumed to be central. The strength of the interaction was treated as a free parameter. The positions of the even-parity levels and their properties agree well with experiment. In particular, a rotational level structure in ^{20}Ne is well explained. It is shown that the harmonic-oscillator wave functions should be modified in the 1s wave function to reproduce the spectrum of ^{18}O. The configuration mixing is very large especially in nuclei of low isobaric spin. The central residual interaction favors the higher symmetric states in the ordinary space. Thus the concept of the symmetry has important physical meaning in these nuclei. The wave functions are found to be very similar to those given by the SU_3 model, but the mixing of different states is caused by the deviation of the residual interaction from the simple Q-Q force. The spin-orbit interaction also destroys the elegance of this SU_3 model. Although this mixing is not so large, the M1 transition probabilities are strongly influenced. (auth)

38112 INVESTIGATION OF SHORT-LIVED ISOMERIC STATES WITH HALF-LIVES IN THE μs AND ms REGION. K. Brandi, R. Engelmann, V. Hepp, E. Kluge, H. Krehbiel, and U. Meyer-Berkhout (Universität, Heidelberg). Nucl. Phys., 59: 33-55(Oct. 1964).

Unique experimental isotope assignments are presented for fifteen previously reported isomeric states with half lives in the μsec and msec region. The isomers were produced by photonuclear reactions. The assigned activities are 49.5 μsec ^{44m}Sc, 10.2 μsec ^{58m}Co, 5.1 μsec ^{62m}Ge, 17.5 μsec ^{101m}Ru, 1.7 msec ^{103m}Ru, 155 μsec ^{115m}Sn, 49 μsec ^{175m}Hf, 10.5 μsec ^{176m}Hf, 8.3 μsec ^{177m}Hf, 70 μsec ^{186m}Re, 225 μsec ^{187m}Os, 92 μsec ^{201m}Hg, 21 μsec ^{203m}Hg, 2.1 msec ^{201m}Tl and 62 μsec ^{204m}Tl. The isotope assignments of the following three short-lived activities remained ambiguous: 11.5 μsec ^{100m}Ru or ^{100m}Tc, 710 μsec ^{101m}Ru or ^{101m}Tc and 10.4 μsec ^{109m}Cd or ^{109m}Ag. In addition, a new 435 μsec isomeric state in ^{43}Sc and a new 18 μsec isomeric state in ^{177}Hf were discovered. Additional results include improved values for half-lived and gamma energies for these isomeric transitions and detailed measurements on the decay properties of some of the reported short-lived isomeric states. The multipolarities of a few of the observed transitions were determined. (auth)

38113 ELASTIC SCATTERING OF RELATIVISTIC ELECTRONS BY SCREENED GOLD AND MERCURY NUCLEI. G. Holzwarth and H. J. Meister (Universität, Munich). Nucl. Phys., 59: 56-64(Oct. 1964).

Using a relativistic Hartree potential, the asymmetry function and cross section for electron scattering are computed numerically at 1-degree intervals for all angles according to the Mott formula. Calculations are performed for Z = 79 and 80 for about 30 different energies between 0.2 and 290 kev. The results are compared with the data of experimental and other theoretical papers. (auth)

38114 A SEARCH FOR H^4 AND Li^4. W. L. Imhof, F. J. Vaughn, L. F. Chase, Jr., H. A. Grench, and M. Walt (Lockheed Research Labs., Palo Alto, Calif.). Nucl. Phys., 59: 81-8(Oct. 1964).

A search for ^{4}H and ^{4}Li was made by looking for radioactive nuclei produced in the following reactions: ^{3}He(p,γ)^{4}Li, ^{3}He(d,n)^{4}Li, ^{3}H(d,p)^{4}H and ^{3}H(n,γ)^{4}H. The possible existence of ^{4}Li was also investigated by attempting direct observation of the gamma rays produced in the ^{3}He(p,γ)^{4}Li reaction. In none of the measurements was any evidence seen for the existence of ^{4}Li or ^{4}H, only upper limits to the cross sections were obtained. The upper limits provide strong, but not conclusive, evidence against the existence of a bound state of ^{4}H or ^{4}Li. (auth)

38115 A SEMI-EMPIRICAL STUDY OF THE SHELL MODEL PROTON-NEUTRON INTERACTION. J. M. Ferguson (Naval Radiological Defense Lab., San Francisco). Nucl. Phys., 59: 97-112(Oct. 1964).

The effective proton-neutron interaction in nuclei is approximated by an extreme short-range force with an ordinary and a spin-dependent component. This interaction is applied to several odd nuclei with two nucleons (or holes) outside of closed shells throughout the periodic table. Simple harmonic oscillator wave functions are used to evaluate the radial integrals. The interaction strength and the ratio of spin-dependent to ordinary force are determined empirically. It is found that the simple model reproduces the interaction with about 30% accuracy. It also indicates that a larger interaction constant should be used when the pro-

ton and neutron are in the same single-particle state than when they are in different states. (auth)

38116 NEUTRON SCATTERING FROM NUCLEI NEAR A = 20 AT ENERGIES BELOW 2.2 Mev. A. J. Elwyn, J. E. Monahan, R. O. Lane, and A. Langsdorf, Jr. (Argonne National Lab., Ill.). Nucl. Phys., 59: 113-26(Oct. 1964).

The polarization and differential cross sections for neutrons scattered from F, Na, Al and P were measured at five scattering angles, at energies from 0.2 to 2.2 Mev, with incident-energy spreads of 100 to 150 kev. Structure, characterized by peaks that are separated by energy intervals of 300 to 400 kev and having widths from 100 to 200 kev, was observed in the total and differential cross sections and in the polarization for these nuclei. Calculations based on a nuclear optical model are in reasonable agreement with an average through the measured total and differential cross sections, but give somewhat poorer fits to an average through the measured polarizations. The observed fluctuations cannot be reproduced by any calculations based on an optical-model potential with fixed or slowly varying parameter values. The possible interpretations of this structure are discussed. (auth)

38117 ISOBARIC SPIN NON-CONSERVATION IN THE DELAYED ALPHA DECAY OF Na^{20}. R. D. Macfarlane (McMaster Univ., Hamilton, Ont.) and A. Siivola. Nucl. Phys., 59: 168-76(Oct. 1964).

The alpha spectra of the products of ^{20}Ne ion reactions with Al, Cu, Ni, ^{102}Pd, and ^{96}Ru at 80 to 200 Mev were measured. Four alpha groups were observed, corresponding to transitions from known 2^+ states in ^{20}Ne at 7.40, 7.82, 9.48, and 10.28 Mev to the ground state of ^{16}O. Evidence was obtained supporting the suggestion that the 10.28-Mev level is the lowest lying T = 1 state of ^{20}Ne. The effect of isobaric spin admixing was clearly observed in enhanced beta transition rates and hindered alpha transitions. (D.C.W.)

38118 SINGLE-PARTICLE AND COLLECTIVE MODELS IN DEFORMED ODD-MASS NUCLEI. A. Faessler (Universität, Freiburg i. B.). Nucl. Phys., 59: 177-201 (Oct. 1964). (In German)

A model for deformed odd-mass nuclei is described in which the nucleon is coupled to a vibrating core with axially symmetric equilibrium deformation. The hamiltonian consists of two parts: the hamiltonian H_c of the rotating and vibrating core, including the rotation-vibration interaction and the hamiltonian H_p for the motion of a single particle in a rotating and vibrating oscillator potential with $l \cdot s$ and l^2 terms. A consistent solution of this problem gives the well-known rotation-particle coupling term and the following terms: a vibration-particle, a rotation vibration and a rotation-vibration-particle coupling term. The energy eigenvalues and eigenfunctions are obtained by an exact diagonalization of the hamiltonian using an appropriate core-particle basis. The model yields the two different γ-bands which were detected recently. For testing the model all available experimental data for ^{153}Eu, ^{161}Dy, and ^{185}Re are compared with the adiabatic Bohr-Mottelson-Nilsson theory. The agreement is much better with this model than with the adiabatic model. (auth)

38119 FIRST FORBIDDEN β-TRANSITIONS IN DEFORMED ODD-MASS NUCLEI. Amand Faessler and Hans Georg Wahsweiler (Universität, Freiburg i. B.). Nucl. Phys., 59: 202-10(Oct. 1964). (In German)

The collective model with vibration-rotation interaction, which was previously extended to odd-mass nuclei, is used to derive expressions for the reduced matrix elements of first-forbidden beta decay. Log ft values are calculated in Konopinski-Uhlenbeck approximation for β^- transitions to various levels of ^{153}Eu and ^{185}Re. Satisfactory agreement with experiment is obtained. (auth)

38120 AN APPLICATION OF THE SEPARATION METHOD IN O^{18} AND Ne^{20}. T. Engeland and A. Kallio (NORDITA, Copenhagen). Nucl. Phys., 59: 211-24(Oct. 1964).

The low-lying energy levels of ^{18}O and ^{20}Ne are calculated with a well-behaved force of Yukawa type and with a hard core force, both of which fit the low-energy properties of the free two-body system. For the latter one a Scott-Moszkowski separation method is used, and only the long-range part of the force is included in the calculations. It is shown that the s-wave part of the forces (only this part was fitted in the free two-body system) gives the best result. (auth)

38121 SCATTERING OF POLARIZED d-T NEUTRONS FROM HELIUM. R. L. Walter, W. Benenson, T. H. May, and C. A. Kelsey (Univ. of Wisconsin, Madison). Nucl. Phys., 59: 235-40(Oct. 1964). (COO-7-330)

The asymmetry in the scattering of d-T neutrons from helium was measured for incident deuteron energies between 6 and 11 Mev at various emission angles. Asymmetries greater than 0.35 were observed at 30° emission angle throughout the energy region investigated. Because of current uncertainty in the analyzing power of helium, the neutron polarization cannot be accurately calculated at present. However, angular distributions of the asymmetries are very similar to the proton polarizations from the mirror reaction $^3He(d,p)^4He$. Arguments based on the charge symmetry of nuclear forces suggest that the neutron polarization is about 0.6 in this energy region. (auth)

38122 STUDIES OF THE (d,α) REACTION ON N^{14} IN THE DEUTERON ENERGY RANGE FROM 1 TO 2.5 Mev. N. A. Mansour, H. R. Saad, Z. A. Saleh, E. M. Sayed, I. I. Zaloubovsky, and V. J. Gontchar (Atomic Energy Establishment, Cairo). Nucl. Phys., 59: 241-52(Oct. 1964).

Angular distributions and excitation functions for the first four groups of alpha particles from the reaction $^{14}N(d,\alpha)^{12}C$ were studied. The angular distribution of the α_0 group was measured at twelve deuteron energies between 1.1 and 2.5 Mev. A marked forward peaking is observed in the angular distribution of the α_0 group at E_d = 1.1 Mev and above. The α_1 group shows a forward peak in the angular distribution at deuteron energies 1.5 Mev and higher. The angular distribution of the α_2 group is virtually isotropic up to the deuteron energy of 2.2 Mev and that of the group α_3 varies strongly with energy. Excitation curves for the groups α_0, α_1, α_2, and α_3 measured at the angle of 90° show a smooth energy dependence. Slight irregularities were observed in the excitation function of the group α_0 at E_d = 1.65, 1.85, and 2.2 Mev measured at the angle of 20°. The angular distribution of the α_0 group was found to be in satisfactory agreement with the predictions of the two-particle pickup theory. (auth)

38123 TOTAL NUCLEON-HELIUM CROSS SECTION NEAR 147 Mev. J. N. Palmieri (Oberlin Coll., Ohio and Harvard Univ., Cambridge, Mass.) and R. Goloskie. Nucl. Phys., 59: 253-6(Oct. 1964).

Protons with energies of 141 and 154 Mev were scattered by a target containing liquid helium. The cross section was measured for incident protons not to leave the target within a cone (half-angle 6°) in the forward direction. At an average proton energy of 147 Mev the cross section was 113.4 ± 0.8 mb. This datum along with proton-helium differential

cross section and polarization data at 147 Mev were analyzed using the impulse approximation and yielded a value of the total neutron-helium cross section of 114.5 ± 1.0 mb. (auth)

38124 THE REACTION $^{19}F(d,p\gamma)^{20}F$. P. R. Chagnon (Univ. of Notre Dame, Ind.). Nucl. Phys., 59: 257-73(Oct. 1964).

With a deuteron energy of 0.47 Mev, proton- and gamma-ray spectra and gamma-gamma and proton-gamma coincidences in $^{19}F(d,p\gamma)^{20}F$ were studied. A decay scheme for excited levels up to 3.5 Mev was deduced. Proton-gamma directional correlations through some of the low-lying levels were measured and were analyzed in terms of the distorted-wave theory of direct interactions. The results are consistent with the former assignment of $J = 1^+$ for the 1.06-Mev level, and permit a new assignment of $J = 2^+$ to be made for the 1.31-Mev level. For the first-excited level at 0.65 Mev, relations between the spin and the quadrupole-dipole mixing ratio were found. (auth)

38125 SPIN-FLIP SCATTERING OF HIGH-ENERGY PROTONS FROM (s,d) SHELL NUCLEI. Mitsuji Kawai (Univ. of Pittsburgh), Tokuo Terasawa, and Koichi Izumo. Nucl. Phys., 59: 289-313(Oct. 1964).

Peaks in the energy spectra at forward angles, measured by Tyrén and Maris, of 185-Mev protons inelastically scattered from (s,d) shell nuclei are interpreted as due to spin-flip scattering associated with the excitation of M1 giant resonance levels of the residual nuclei. Cross sections are estimated using the distorted-wave impulse approximation together with the γ-widths of the relevant levels known from other experiments. Good order-of-magnitude agreement with the observed cross sections is obtained. Comparison is made of various approximations for calculating the cross sections, and it is concluded that the zero-range approximation for the scattering operator together with the WKB approximation for the distorted wave constitute a good approximation to a finite range, exact distorted-wave impulse approximation. It is also shown that only the imaginary part of the distorting potential affects the results appreciably. The position and the transition strength of those levels which are strongly excited by the spin-flip process are calculated using very simple nuclear models, i.e., jj-coupling single-particle model and quasi-particle pair model, fair agreement with experiment being obtained. It is suggested that the excitation of those levels is essentially of single-particle rather than collective nature. Further experiments to test this suggestion are proposed. (auth)

38126 THE $Al^{27}(d,\alpha)Mg^{25}$ AND $F^{19}(d,\alpha)O^{17}$ REACTIONS AND THE 2I + 1 RULE. M. F. Jahns, J. B. Nelson, and E. M. Bernstein (Univ. of Texas, Austin). Nucl. Phys., 59: 314-20(Oct. 1964).

Total cross sections were determined for the $^{27}Al(d,\alpha)$ ^{25}Mg and $^{19}F(d,\alpha)^{17}O$ reactions in the bombarding range 2–3 Mev. These cross sections are compared with 2I + 1 where I is the spin of the residual nucleus. A direct proportionality to 2I + 1 occurs in the $^{27}Al(d,\alpha)^{25}Mg$ reaction, but is not present in the $^{19}F(d,\alpha)^{17}O$ reaction in the energy range investigated. (auth)

38127 THE SCATTERING OF 14.1 Mev NEUTRONS BY Ca^{40}. W. J. McDonald and J. M. Robson (Univ. of Ottawa). Nucl. Phys., 59: 321-31(Oct. 1964).

Differential cross sections for the scattering of 14.1-Mev neutrons from the ground state and from the excited states of 3.7 and 6.7 Mev were measured for laboratory angles between 20 and 160°. The optical model potential which gives the best fit to the elastic differential cross section was used in a DWB calculation to fit the measured differential cross section for scattering from the state at 3.7 Mev. For this calculation the state was represented by a collective octupole vibration of the nuclear surface. The observed differential cross section is in good agreement with the DWB prediction. (auth)

38128 COULOMB EXCITATION IN Na^{23}, Mn^{55}, Sm^{152}, Sm^{154}, Ho^{165} AND Tm^{169}. B. W. Hooton (Univ. of Manchester, Eng.). Nucl. Phys., 59: 332-40(Oct. 1964).

Fluorine compounds NaF, MnF_2, SmF_3, HoF_3, and TmF_3 were bombarded with 11.0-Mev nitrogen ions, and γ-ray intensities measured relative to the strength of 197-kev γ rays from ^{19}F. It was assumed that Coulomb excitation was responsible for the γ rays and that the excitation cross section of the 197-kev level in ^{19}F could be calculated from the lifetime of the state. Values of B(E2) for excitation of the first excited states in ^{23}Na, ^{55}Mn, ^{152}Sm, and ^{154}Sm were found to be 0.015 ± 0.003, 0.047 ± 0.003, 3.4 ± 0.2, and 5.1 ± 0.4, respectively, in units of $e^2 \times 10^{-48}$ cm^4. The results for ^{165}Ho and ^{169}Tm were analyzed in terms of conversion coefficients using values of B(E2) obtained from inelastic scattering. The total conversion coefficients for the 95-kev level in ^{165}Ho and the 118-kev level in ^{169}Tm were found to be 2.9 ± 0.2 and 1.9 ± 0.2, respectively. (auth)

38129 NUCLEAR INTERACTIONS OF SUPER-HIGH-ENERGY ALPHA-PARTICLES. A. Tomaszewski (Inst. of Nuclear Research, Lodz, Poland). Nuovo Cimento (10), 33: 993-1000(Aug. 16, 1964).

Angular distributions of secondaries from collisions of α particles with energies higher than 10^{12} ev/nucleon with emulsion nuclei were analyzed. It was found that the group of jets with small evaporations ($N_h \leq 5$) and small multiplicities ($n_s \leq 20$) is due to collisions of a single nucleon from the α particle, the angular distribution of secondaries being quite similar to those in nucleon-nucleon collisions. The angular distributions of jets with $N_h \leq 5$, $20 < n_s < 50$, and $\sigma > 0.6$ show a double maximum structure and can be explained as a superposition of angular distributions from independent collisions of two or three nucleons from the α particle. However, angular distributions of jets with α primaries and $N_h > 8$ can be described by a normal distribution which is not the case for jets with nucleon primaries. (auth)

38130 DIRECT MEASUREMENT OF μ^- MESONIC MOLECULE FORMATION RATES IN LIQUID HYDROGEN. G. Conforto (CERN, Geneva), C. Rubbia, E. Zavattini, and S. Focardi. Nuovo Cimento (10), 33: 1001-19(Aug. 16, 1964).

A measurement of the μ^-pp and μ^-pd mesonic molecule formation rate in liquid hydrogen is described. The capture probability of μ^- from the neon nucleus is given. The results are compared with those obtained by others. (auth)

38131 MUON CAPTURE IN OXYGEN. A. Astbury, L. B. Auerbach, D. Cutts, R. J. Esterling, D. A. Jenkins, N. H. Lipman, and R. E. Shafer (Univ. of California, Berkeley). Nuovo Cimento (10), 33: 1020-4(Aug. 16, 1964). (UCRL-11299)

Muon capture in oxygen was studied at the 184-inch cyclotron. Muons were identified by a time-of-flight system and brought to rest in a water-cell, where some of them were captured by the ^{16}O nucleus. In the present state of the theory, the only firm conclusion is that the pseudoscalar coupling constant is positive. (auth)

38132 THE GROUND-STATE WAVE FUNCTION OF ^{210}Bi. H. Pollak (Lovanium Univ., Léopoldville, Congo). Nuovo Cimento (10), 33: 1067-73(Aug. 16, 1964).

From the experimental values of the magnetic momen-

tum, the quadrupole moment and the β-decay matrix elements, one deduces the ^{210}Bi ground-state wave function and the sign of the magnetic and quadrupole moments. (auth)

38133 A ROTATIONAL-OPTICAL MODEL ANALYSIS OF FAST-NEUTRON SCATTERING BY ^{238}U NUCLEUS. B. Baldoni and A. M. Saruis (CNEN, Bologna). Nuovo Cimento (10); 33: 1145-63(Aug. 16, 1964).

The neutron scattering by ^{238}U nucleus in the energy range (0.05–15) Mev was analyzed in terms of a rotational-optical model. A linear dependence by target deformation was assumed for the interaction potential. For the dipole and quadrupole strengths diffuse edge optical potentials were adopted. With a reasonable choice of the free parameters a good fit of the experimental data was obtained in the energy range considered. (auth)

38134 AN ALTERNATIVE INTERPRETATION OF AN EVENT REPORTED AS AN INTERACTION OF A HYPERON OF STRANGENESS −2. R. J. Prem and P. H. Steinberg (Univ. of Maryland, College Park). Nuovo Cimento (10), 33: 1214(Aug. 16, 1964).

An alternate interpretation is presented for a previously reported event in which a hyperon (Ξ^-), produced in a 1.5 Bev/c meson (K^-) star in emulsions, was proposed to interact at rest producing two hyperfragments. It is postulated that the previous interpretation of the capture reaction is ruled out by energy conservation. (C.E.S.)

38135 REPLY TO THE PREVIOUS LETTER "AN ALTERNATIVE INTERPRETATION OF AN EVENT REPORTED AS AN INTERACTION OF A HYPERON OF STRANGENESS −2. B. Bhowmik (Brookhaven National Lab., Upton, N. Y.). Nuovo Cimento (10), 33: 1215 (Aug. 16, 1964).

New evidence is reported to substantiate the original interpretation of an event in which a hyperon (Ξ^-), produced in a 1.5- Bev/c meson (K^-) star in emulsions, was proposed to interact at rest producing two hyperfragments. (C.E.S.)

38136 ENERGY-DEPENDENCE OF BACKWARD ELASTIC SCATTERING OF FAST NEUTRONS ON ^{32}S. M. Mangialajo (CISE, Milan), F. Merzari, P. G. Sona, J. Vuletin, M. Fazio, and M. Monti. Nuovo Cimento (10), 33: 1228-31(Aug. 16, 1964).

An experiment to determine if compound elastic scattering is the dominant process at backward angles for fast neutrons is described. The energy dependence of the differential cross section for neutron scattering on S and Sn targets at energies of 13.8 to 14.7 Mev was determined. (C.E.S.)

38137 A NOTE ON DIFFRACTION DISSOCIATION ON COMPLEX NUCLEI. S. Ratti (Università, Milan). Nuovo Cimento (10), 33: 1232-5(Aug. 16, 1964).

Coherent interaction of high-energy particles in nuclear matter and the diffraction dissociation of beam particles are discussed. It is pointed out that the phenomenon may be particularly sensitive to nuclear structure of the target. The previously reported (ρ-π) interaction at ~1.2 Bev is discussed. (C.E.S.)

38138 DETERMINATION OF THE SIGN OF QUADRUPOLE COUPLING AND ABSOLUTE MEASUREMENT OF THE SPIN TEMPERATURE OF DYNAMICALLY POLARIZED NUCLEI. A. Abragam and M. Chapellier (CEN, Saclay, France). Phys. Letters, 11: 207-8(Aug. 1, 1964). (In French)

Lanthanum-139 ($I = 7/2$) was polarized in $LaMg(NO_3)_2 \cdot xH_2O$ doped with 1% paramagnetic Nd (^{142}Nd) at 1.5°K, using an 18-kG magnetic field. From relative transition intensities, the quadrupole coupling was determined to be positive. The spin temperature was evaluated to be 1.2×10^{-3}°K. (D.C.W.)

38139 DEUTERON- AND TRITON-REDUCED WIDTHS OF THE SHELL MODEL. A. Sandulescu (Inst. for Atomic Physics, Bucharest) and O. Dumitrescu. Phys. Letters, 11: 240-2(Aug. 1, 1964).

The reduced widths for deuteron and triton channels of low levels of some light nuclei were calculated by taking into account the structure of the emitted particles. (D.C.W.)

38140 A TEST OF THE CHARGE-INDEPENDENT MASS FORMULA FOR ISOBARIC ANALOG STATES OF A = 24. D. H. Wilkinson (Nuclear Physics Lab., Oxford). Phys. Letters, 11: 243-4(Aug. 1, 1964).

The mass of the ground state of the $T_z = -1$ nucleus with A = 24 was predicted to be 4.49 ± 0.15 Mev, assuming charge independence. The experimental value obtained from the ^{24}Mg(p,n)^{24}Al reaction was 4.53 ± 0.30 Mev. (D.C.W.)

38141 DOUBLE CHARGE EXCHANGE WITH POSITIVE PIONS. L. Gilly, M. Jean, R. Meunier, M. Spighel, J. P. Stroot, P. Duteil, and A. Rode (CERN, Geneva and Laboratoire de Physique Nucleaire, Orsay, France). Phys. Letters, 11: 244-8(Aug. 1, 1964).

The differential cross sections for double charge exchange of mesons (π^+) on Be, Li, and Na at 195 Mev were determined by detecting the mesons (π^-) produced in the forward direction with a DISC spectrometer. (D.C.W.)

38142 ENERGY VARIATION OF THE PHASE RULE IN ALPHA PARTICLE SCATTERING. J. R. Meriwether (Univ. of California, Berkeley), A. Bussiere de Nercy, B. G. Harvey, and D. J. Horen. Phys. Letters, 11: 299-300(Aug. 15, 1964).

The angular distributions for alpha scattering at 25, 33, 50, 85, and 100 Mev by thin ^{62}Ni targets to ^{62}Ni levels were measured. A smooth variation from out-of-phase to in-phase with the elastic distribution apparently occurs as the incident alpha particle energy increases. The data were compared with the diffraction model. (D.C.W.)

38143 THE MAGNETIC MOMENT OF THE 3^- STATE IN O^{16}. B. Diehl (NORDITA, Copenhagen). Phys. Letters, 11: 301-2(Aug. 15, 1964).

The magnetic moment of the T = 0, 3^- state was calculated to be 1.53 nm, using a wave function given by Elliott and Flowers. (D.C.W.)

38144 THE ELASTIC SCATTERING OF 12.0 Mev He^3 PARTICLES BY NUCLEI. J. L. Yntema (Argonne National Lab., Ill.), B. Zeidman, and R. H. Bassel. Phys. Letters, 11: 302-4(Aug. 15, 1964).

The angular distributions for elastic scattering of ^{3}He by ^{24}Mg, ^{40}Ca, ^{45}Sc, ^{46}Ti, ^{48}Ti, ^{50}Ti, ^{51}V, ^{54}Fe, ^{58}Ni, ^{64}Zn, and ^{90}Zr at 12 Mev were measured and the data were analyzed by an optical model. The differential cross sections show little structure as a function of angle, permitting good fits with potentials having a variety of shapes. The angular distributions for all targets, except ^{40}Ca and ^{24}Mg, were fitted with the same potential. The main features of the scattering can be with a potential that varies smoothly with atomic mass. (D.C.W.)

38145 THE VARIATION OF ENERGY GAP IN ROTATIONAL STATES OF NUCLEI. K. Y. Chan and J. G. Valatin (Univ. of Birmingham, Eng.). Phys. Letters, 11: 304-5 (Aug. 15, 1964).

The dependence of the energy gap on the angular velocity and the effective moment of inertia were investigated, using an oscillator shell model potential for ^{180}Hf. The variation

of the neutron and proton gaps with angular velocity and angular momentum quantum number was obtained, together with the contributions of the neutrons and protons to the moment of inertia as a function of the energy gap. Notably, the existence of two rather different gap curves and critical rotational quantum numbers for neutrons and protons was observed. (D.C.W.)

38146 SHAPES OF NEUTRON INELASTIC SCATTERING SPECTRA AND NUCLEAR TEMPERATURES. K. K. Seth (Northwestern Univ., Evanston, Ill. and Duke Univ., Durhan, N. C.), R. M. Wilenzick, and T. A. Griffy. Phys. Letters, 11: 308-11(Aug. 15, 1964).

The energy spectra of neutrons inelastically scattered at 6.04 Mev from several medium and heavy nuclei were measured. Differences between the spectral shapes for elements with mass numbers differing by 10 to 20 units were attributed to the energy dependence of the cross section for compound nucleus production by neutrons incident on an excited nucleus. The data were analyzed by the compound nuclear and optical models. Nuclear temperatures and Fermi gas coefficients were obtained. Apparent angle dependence of the nuclear temperatures was observed. (D.C.W.)

38147 STUDY OF SECOND EXCITED 2^+ STATES IN EVEN-EVEN NUCLEI THROUGH β-γ ANGULAR CORRELATIONS. R. S. Raghavan, Z. W. Grabowski, and R. M. Steffen (Purdue Univ., Lafayette, Ind.). Phys. Letters, 11: 311-13(Aug. 15, 1964).

Anisotropy factors for beta transitions of ^{122}Sb and ^{76}As to the first and second excited states of ^{122}Te and ^{76}Se were obtained by β-γ coincidence measurements. For ^{122}Sb, the anisotropy factor for the first excited state is independent of beta energy, while that for the second excited state is energy dependent. An energy-independent anisotropy for the transition to the second excited state in ^{76}As was obtained. For both nuclei, the two anisotropy factors were quite different. (D.C.W.)

38148 OPTICAL MODEL ANALYSIS OF 182-Mev PROTON SCATTERING. G. R. Satchler (Oak Ridge National Lab., Tenn.) and R. M. Haybron. Phys. Letters, 11: 313-15(Aug. 15, 1964). (ORNL-P-191)

Elastic scattering of protons by Be, Ca, C, Au, Fe, In, Al, and Li at 182 Mev was analyzed by the optical model. The parameters providing the best fits are presented, together with experimental and theoretical cross sections. (D.C.W.)

38149 CENTRIFUGAL STRETCHING OF NUCLEI. R. M. Diamond, F. S. Stephens, and W. J. Swiatecki (Univ. of California, Berkeley). Phys. Letters, 11: 315-18 (Aug. 15, 1964). (UCRL-11421)

It is shown that a classical treatment incorporating the centrifugal stretching of a spinning nucleus reproduces the quantum mechanical Davydov-Chaban calculations for energy spacing and accounts for the rotational spectra with notable accuracy. The bases for the agreement and for the remaining deviations are discussed. (D.C.W.)

38150 DIPOLE PHOTOEFFECT IN O^{16}. F. Villars (Massachusetts Inst. of Tech., Cambridge) and M. S. Weiss. Phys. Letters, 11: 318-21(Aug. 15, 1964). (MIT-2098-53)

A theory for nuclear continuum states is outlined, with preliminary application to the dipole transition in ^{16}O. (D.C.W.)

38151 AN ENHANCED E3 TRANSITION IN Ne^{20}. C. Broude, A. E. Litherland, and J. D. Pearson (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Letters, 11: 321-3(Aug. 15, 1964).

Enhancement of the E3 gamma transition from the 5.63-Mev, 3^- level of ^{20}Ne to the 0^+ ground state by a factor of 7 over the single-particle estimate was observed. The observation is consistent with the interpretation of the 5.63-Mev level as the second member of a K = 2 octupole g-vibrational band based on the 2^-, 4.97-Mev level. (D.C.W.)

38152 PHOTONEUTRONS FROM MEDIUM ELEMENTS UP TO 80 Mev PHOTON ENERGY. S. Costa (Università, Turin and Istituto Nazionale Fisica Nucleare, Turin), F. Ferroni, S. Ferroni, C. Molino, and R. Malvano. Phys. Letters, 11: 324-6(Aug. 15, 1964).

Photoneutron emission by ten elements ranging from Z = 24 to 33 was investigated. Yields and cross sections were obtained, including the maximum yields and bremsstrahlung weighted total neutron cross sections for twenty element from Z = 6 to 33. (D.C.W.)

38153 ELASTIC ALPHA-HELIUM SCATTERING UP TO 120 Mev. P. Darriulat (Univ. of California, Berkeley), G. Igo, H. G. Pugh, and H. D. Holmgren. Phys. Letters, 11: 326-8(Aug. 15, 1964). (UCRL-11455)

The differential cross section for elastic scattering of alpha particles by helium was measured as a function of center-of-mass angle between 10 and 90° at seven energies between 53 and 120 Mev. The cross sections were fitted with an expansion using complex phase shifts in which the imaginary part accounts for the effect of nuclear reactions. The phase shifts were fitted with a potential including terms representing a repulsive core, an attractive outer region, an absorption potential, and a Coulomb potential. An attempt to fit the phase shifts as a function of energy with an angular momentum independent potential failed. Analysis of the i and k resonances by the single-level dispersion theory was also attempted. (D.C.W.)

38154 CROSS SECTIONS FOR REACTIONS WITH ANALOG STATE RESONANCES. G. A. Jones, A. M. Lane, and G. C. Morrison (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phys. Letters, 11: 329-31(Aug. 15, 1964).

Formulas for the cross sections of proton reactions through analog states are given and discussed, together with the results of measurements on the reactions $^{89}Y(p,p')^{89*}Y$ and $^{89}Y(p,\gamma)^{90*}Zr$. Evidence that states of lower isobaric spin are strongly mixed with the analog states was noted. (D.C.W.)

38155 SHELL MODEL EFFECTS ON NEUTRON OPTICAL MODEL ABSORPTION. W. G. Vonach, A. B. Smith, and P. A. Moldauer (Argonne National Lab., Ill.). Phys. Letters, 11: 331-3(Aug. 15, 1964).

The differential cross sections for neutron elastic scattering by Bi, Au, Hg, and Tl were measured at 50-kev intervals from 0.3 to 1.5 Mev at angles between 20 and 145°. A good optical model fit to the data was obtained by letting the imaginary potential W decrease from 14 Mev at Au to 5 Mev at Bi. The same procedure also gave better agreement for the mass dependence of measured s-wave strength functions in the region A = 190 to 210. The results indicate a minimum in W near the doubly closed shell at A = 208. (D.C.W.)

38156 INTERPRETATION OF ANOMALIES OBSERVED IN (n,α) SYSTEMATICS AT E_n = 14 Mev. A. Rubbino and D. Zubke (Lohann-Wolfgang-Goethe Universitat, Frankfurt am Main). Phys. Letters, 11: 333-5(Aug. 15, 1964).

The divergences of the statistical theory from the experi-

mental (n,α) cross section at 14 Mev for nuclei with A > 70 is explained in terms of an indirect but strong effect of the Q value for the reaction on the magnitude of the calculated cross section for nuclei with relatively high mass numbers. (D.C.W.)

38157 THE OBSERVATION OF A HEAVY HELIUM HYPERNUCLEUS. J. Lemonne (Université Libre, Brussels), C. Mayeur, M. Rayet, et al. Phys. Letters, 11: 342-4(Aug. 15, 1964).

A heavy helium hypernucleus was observed in the production of hypernuclei by meson(K^-) absorption at rest in nuclear emulsion. Analyses of the decay and production processes indicate that the event is probably $K^{-}_{+C}{}^{12} \rightarrow {}^{8}_{\Lambda}He + 3p + n$, ${}^{8}_{\Lambda}He \rightarrow \pi^- + {}^{8}Li$. (D.C.W.)

38158 HYPERFINE STRUCTURES OF THE RESONANCE LINE OF THE ARC SPECTRA AND NUCLEAR QUADRUPOLE MOMENTS OF THE ISOTOPES 135 AND 137 OF BARIUM. D. A. Jackson and Duong Hong Tuan (CNRS, Bellevue, France). Proc. Roy Soc. (London), Ser. A, 280: 323-39(July 28, 1964).

The hfs of the resonance line of the arc spectra of ^{135}Ba and ^{137}Ba were determined by observing the absorption of atomic beams enriched in one or other of these isotopes; the recently developed technique of operating the atomic beam between the plates of the interferometer enabled strong absorptions to be obtained over long periods, at high collimation, with the limited quantities of enriched isotopes available. In both cases the hfs consists of three components, with intensity ratios of 3:2:1 (in order of increasing wave number); their positions relative to the single line of ^{138}Ba are given. The magnetic moment splitting factor, A, and the quadrupole moment coupling factor, B, of the term $6s6p\,{}^1P_1$ are found; the ratios of the values of these factors for the two isotopes are in good agreement with those found by nuclear resonance methods. The isotope shifts of ^{137}Ba and ^{135}Ba relative to ^{138}Ba derived from these measurements are respectively 7.0 ± 0.3 and 8.1 ± 0.3 mK. The values of Q, the nuclear quadrupole moment of ^{137}Ba and of ^{135}Ba, are derived from the values found for the coupling factors, B. The isotope shifts of ^{136}Ba and of ^{134}Ba relative to ^{138}Ba were also measured by this method, for samples enriched in one or other of these isotopes and in ^{138}Ba; they are respectively 4.2 ± 0.2 and 4.6 ± 0.1 mK. (auth)

38159 ISOTOPE SHIFT IN THE ARC SPECTRUM OF RUTHENIUM. W. H. King (Oxford Univ.). Proc. Roy. Soc. (London), Ser. A, 280: 430-8(July 28, 1964).

With the use of enriched isotopes of ruthenium, the isotope shifts in six lines of the arc spectrum of Ru were studied. A Fabry-Perot etalon, with multiple dielectric coatings, provided the high resolution required. Shifts between all the stable isotopes were measured accurately in the line λ4372 Å, and several shifts were measured in the other five lines. A treatment of the combined results made it possible to derive a relation between the various specific mass shifts. From this, all the specific mass shifts could be determined if one were known. An estimate was made of the proportion of the shift due to mass effects and that due to nuclear volume effects in the different lines. The estimated nuclear volume shifts in λ4372 Å were: 96–98 39.6 mK, 98–99 11.3 mK, 99–100 23.7 mK, 100–101 7.1 mK, 101–102 24.9 mK, and 102–104 35.2 mK. The order of magnitude of the configuration mixing in some odd levels was also found. (auth)

38160 ISOTOPE SHIFT AND HYPERFINE STRUCTURE IN THE SPECTRUM OF TIN. D. N. Stacey (Oxford Univ.). Proc. Roy. Soc. (London), Ser. A, 280: 439-46(July 28, 1964).

Shifts between all the even isotopes of tin (Z = 50) were measured interferometrically, for enriched samples, in the line 3283 Å of the spectrum of Sn II. The hfs and shifts relative to the even isotopes of two of the three odd isotopes were also measured. The results are compared with those on the tin lines 6454 and 5799 Å, in order to obtain absolute values of the volume shift constant for the tin isotopes, which involves estimation of the specific mass shift in the lines, and to calculate the configuration mixing in some of the levels concerned. After allowing for normal mass effect only the measured shifts are: 112–114; 22.0 mK; 114–116, 21.9 mK; 116–118, 18.0 mK; 118–120, 18.4 mK; 120–122, 16.6 mK; 122–124, 11.7 mK; 116–117, 8.4 mK; 118–119, 2.4 mK. A hyperfine doublet was observed in 3283 Å for both ^{117}Sn and ^{119}Sn; the splittings are 153.6 and 162.3 mK respectively and are attributed to the lower level involved in the transition. (auth)

38161 THEORY OF BETA DECAY. M. Morita (Kyoto Univ. and Univ. of California, Berkeley). Progr. Theoret. Phys. (Kyoto), Suppl., No. 26, 1-63(1963).

Theory for beta decay, particularly the beta spectrum in allowed transitions is reviewed, including the conserved vector current hypothesis, corrections, neutrino emission, Fermi theory, various interactions, and Fierz interference. Appropriate experimental observations are also covered. 200 references. (D.C.W.)

38162 CLEBSCH-GORDAN COEFFICIENTS FOR $J_2 = \frac{5}{2}$, 3 AND $\frac{7}{2}$. M. Morita (Kyoto Univ.), R. Morita, T. Tsukamoto, and M. Yamada. Progr. Theoret. Phys. (Kyoto), Suppl., No. 26, 64-74(1963).

The Clebsch-Gordan coefficients for vector addition are tabulated for $j_2 = \frac{5}{2}$, 3, and $\frac{7}{2}$. The formulas from which the coefficients were derived are included. (D.C.W.)

38163 S-STATE INTERACTIONS IN EFFECTIVE TWO-BODY FORCES. Yeshwant Waghmare, Raj K. Gupta, and Naresh Kumar (Univ. of California, San Diego, La Jolla and Panjab Univ., Chandigarh, India). Progr. Theoret. Phys. (Kyoto), 31: 765-71(May 1964).

The energy level spectrum of ^{58}Ni was analyzed in terms of pure singlet s-state forces. By taking the single-particle energy ($p_{3/2}$-$f_{5/2}$ spacing) as a free parameter, the best fit is obtained for $\Delta \approx 0.9$ Mev, which is in fair agreement with the experimentally indicated value of 0.85 Mev for the single-particle level of ^{57}Ni. Several previously unobserved levels are predicted in the energy range from 2.5 to 3.2 Mev. The extension of the analysis to the three-particle configuration suggests a $\frac{3}{2}^-$ ground state for ^{59}Ni. (auth)

38164 THE ANALYTIC PROPERTIES OF THE DISTORTED-WAVE BORN APPROXIMATION AMPLITUDE. Koichi Yazaki (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 31: 772-80(May 1964).

The relation between the dispersion theoretical method and the usual distorted wave Born approximation was examined by investigating the analytic properties of the latter amplitude as a function of energy. With some assumptions, it is shown that the amplitude has analytic properties similar to those usually assumed in the dispersion theoretical method. (auth)

38165 THE DISPERSION THEORETICAL APPROACH TO THE EFFECTS OF THE INELASTIC SCATTERING ON STRIPPING REACTIONS. Koichi Yazaki (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 31: 781-6(May 1964).

The effects of the inelastic scattering in the initial and final states on direct nuclear reactions such as (d,p) reac-

tions are investigated in terms of the dispersion theoretical method. The integral equation for the reaction amplitude is derived, and the explicit solution is given. It is assumed that the elastic and the inelastic scattering amplitudes can be written in the form ND^{-1}. (auth)

38166 SELF-BOUND FINITE SYSTEM. Tatuya Sasakawa (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 31: 787-98(May 1964).

Starting from an N(≥2)-body system, the bound state energy and the wave functions of any M(>N)-body system are calculated. The approximation which leads to the single-particle model is discussed. The effective single-particle potential is derived under the 1/N-approximation for the strong coupling limit. It takes a form which is similar to the effective single-particle potential in the theory of infinite matter. (auth)

38167 MU-MESIC ATOM FORMATION OF DEFORMED NUCLEUS. Toshitake Kohmura (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 31: 799-803(May 1964).

The suitability of mu-mesic atom formation for probing nuclear deformation is shown. The rate of direct 1s orbit trapping of the low-energy meson(μ) is calculated. The rate is highly enhanced for deformed nuclei. The anisotropy of the rate results from the nuclear deformation. (D.C.W.)

38168 NUCLEAR FORCE AND OBEC-MODEL. Masanori Matsuda and Shoji Sawada (Hiroshima Univ.). Progr. Theoret. Phys. (Kyoto), 31: 804-24(May 1964).

The nuclear force responsible for the p-p scattering below 300 Mev was studied on the basis of the one boson exchange contribution (OBEC) model. The partial transition amplitudes given by the model are so decomposed into five terms that correspond to five types of potential. The differences between the OBEC model and the one boson exchange potential (OBEP) model are discussed using the decomposed amplitudes. An analysis of the LS force and quadratic LS force from the OBEC model indicates that the hard core introduced in conventional potential is unnecessary for all states except the singlet s-state. (auth)

38169 MEASUREMENTS OF THE ANGULAR DISTRIBUTIONS OF $Al^{27}(p,\alpha)Mg^{24}$ REACTIONS AT E_p = 6.6 Mev BY MEANS OF A MAGNETIC ANALYZER. F. Asfur, I. Grancha, E. A. Romanovskii, G. F. Timushev, and M. Khasain. Vestn. Mosk. Univ., Ser. III, Fiz. Astron., No. 1, 21-2(Jan.-Feb. 1964). (In Russian)

Angular distributions of the α particles from the $^{27}Al(p,\alpha)^{24}Mg$ reaction were measured by means of 180- and 90-degree magnetic analyzers. The tabulated differential cross sections of the $^{27}Al(p,\alpha)^{24}Mg$ reaction, corresponding to the excitation of a ground state in ^{24}Mg at E_p = 6.6 Mev, show that the α-particle angular distribution maximum is in the forward direction. The accuracy of the cross section determination is ~15%. (R.V.J.)

38170 THE STRUCTURE OF NUCLEAR QUASIMOLECULES. V. G. Neudachin. Vestn. Mosk. Univ., Ser. III, Fiz. Astron., No. 1, 81-2(Jan.-Feb. 1964). (In Russian)

The recent data presented by E. Almquist et al. (Phys. Rev., 130: 1140(1963)) on the $^{12}C + ^{12}C$ quasimolecule state with small moments 2^+ and 4^+ and the means of the quasimolecular decay were used in the analysis of the wave function of the ^{24}Mg quasimolecular state. The wave function explains all the available data on the decay of the $^{24*}Mg$ quasimolecule and indicates the new channels with large width. In addition, considering the experimental data on the energy of plane state ^{16}O and linear state ^{12}C, it is possible to predict new quasimolecules and explain the absence of quasimolecular states in ^{16}O scattering on ^{16}O. (R.V.J.)

38171 THE EXPERIMENTAL ARRANGEMENT FOR MEASUREMENTS OF CROSS SECTIONS AND ANGULAR DISTRIBUTIONS OF PHOTONUCLEAR REACTION PRODUCTS. N. N. Balamatov, B. S. Ishkhanov, V. G. Shevchenko, and B. A. Yur'ev. Vestn. Mosk. Univ., Ser. III, Fiz. Astron., No. 2, 85-7(Mar.-Apr. 1964). (In Russian)

A design is given of a device capable of measuring zirconium photoproton yields simultaneously at three angles (90°, 90°', and 150°) to the beam. The cross section of the $^{90}Zr(\gamma,p)$ reaction is plotted. (R.V.J.)

38172 STUDY OF THE SU_3 WAVE FUNCTIONS. Hungchou Sun (Peking Univ.). Wu Li Hsueh Pao, 20: 483-500 (June 1964). (In Chinese)

The properties of the SU_3 wave functions, introduced by Elliott, are discussed in detail. By means of the commutation relations of the infinitesimal operators of SU_3 group, the interval wave functions $x(\alpha(\lambda\mu)K)$ can be calculated in a comparatively simple manner. With the use of the internal wave functions $x(\alpha(\lambda\mu)K)$, a formula of the frational parentage coefficients for the SU_3 wave functions $\Psi(\alpha(\lambda\mu)KLM)$ is obtained. As examples the SU_3 wave functions of 2 or 3 nucleons in sd shell are calculated. (auth)

38173 CROSS SECTION OF HIGH-ENERGY ANTINEUTRINO CAPTURE ON O^{16} NUCLEI. Hao-chin Chen. Wu Li Hsueh Pao, 20: 512-17(June 1964). (In Chinese)

By means of the hamiltonian of the V-A variations the cross sections for the reaction $\bar{\nu} + {}^{16}O \rightarrow {}^{16}N + \bar{l}$ were calculated. The cross section was determined as a function of the incident antineutrino energy. Calculations show that for $E\bar{\nu}$ = 400 Mev, the effective pseudoscalar term reduces the cross section by 23%. (tr-auth)

38174 LIFETIME MEASUREMENT OF THE 46-Kev LEVEL OF As-72. A. Huebner and H. Schneider (Justus Liebig-Universität, Giessen, Ger.). Z. Naturforsch., 19a: 809-10(June 1964). (In German)

The lifetime of the 46-kev level of ^{72}As was determined by delayed coincidence measurements between the 10.5 kev γ quanta of the EC-transition of ^{72}Sc and the 46-kev γ quanta of the E_1 transition. ^{72}Sc was produced by the $^{70}Ge(\alpha,2n)$ reaction. The results give a half life of 10.7 ± 0.3 n sec. (L.B.S.)

38175 EXCITATION OF BULK AND SURFACE PLASMA OSCILLATIONS IN Al AND Mg BY INTERMEDIATE-ENERGY ELECTRONS. Peter Schmueser (Universität, Hamburg). Z. Physik, 180: 105-26(1964). (In German)

Dispersion and scattering cross section of the bulk plasma losses of Al and Mg are compared with plasma theory. The low lying Mg loss shows an asymmetric intensity distribution for non-normally incident electrons and an angular dependence of intensity as expected from the theory of surface losses. In very thin Al films, coupling effects between the two opposite surfaces are found, causing some new properties of the surface losses. Especially a thickness dependent dispersion of the surface loss is measured which is quite different from that of the bulk losses and characteristic for surface excitation. (auth)

38176 MEASUREMENT OF UNSYMMETRICAL ANGULAR DISTRIBUTIONS OF CHARACTERISTIC SURFACE LOSSES WITH Al (6.3 ev) AND Ag (3.6 ev). Christof Kunz (Universität, Hamburg). Z. Physik, 180: 127-32(1964). (In German)

The unsymmetrical angular distribution of electrons with energy losses of 6.3 ev with Al and 3.6 ev with Ag due to the excitation of surface plasma oscillations is investigated on

inclined foils of Al and Ag. The results agree with the theory given by Stern and Ferrell. (auth)

38177 ABSOLUTE DETERMINATION OF SOURCE STRENGTH OF EXTENDED SAMPLES BY THE COINCIDENCE METHOD. M. Buechler and A. Hofmann (Universität, Erlangen, Ger.). Z. Physik, 180: 133-42(1964). (In German)

The absolute measurement of activities by the coincidence method can be applied to the case of extended and inhomogeneously activated sources. The corrections due to extension and inhomogeneous activation of the source can be summarized into one correction factor. The procedure for obtaining this factor is described. Measurements are reported for the case of extended ^{24}Na sources, produced by the reaction ^{27}Al(n,α)^{24}Na with 14-Mev neutrons. In this case the correction factor is given in detail. (auth)

38178 SPINS AND γ-MULTIPOLE ARRANGEMENTS IN DECAY OF $Fe^{59} \rightarrow Co^{59}$. W. Collin, H. Daniel, O. Mehling, H. Schmitt, G. Spannagel, and K. S. Subudhi (Max-Planck-Institut für Kernphysik, Heidelberg). Z. Physik, 180: 143-9(1964). (In German)

In the decay of ^{59}Fe the following quantities were measured: γ-ray intensities, conversion coefficients, and β-(circularly polarized γ) correlations. The conversion coefficients were found to be: for the 1.10-Mev γ transition, $\alpha_{tot.} = (1.36 \pm 0.10) \cdot 10^{-4}$ and for the 1.29-Mev γ-transition, $\alpha_{tot.} = (1.07 \pm 0.08) \cdot 10^{-4}$. The asymmetry parameters A of the correlation β(0.27 Mev) − γ(1.29 Mev) were measured to be $A = -0.17 \pm 0.10$, and for β(0.46 Mev) − γ(1.10 Mev), $A = -0.13 \pm 0.04$. From these data and published γ-γ angular correlation measurements the following spins of ^{59}Co levels could be deduced: 1.10 Mev, $I = 5/2^-$; 1.29 Mev, $I = 5/2^-$; and 1.43 Mev, $I = 3/2^-$. The two strong β-ray groups are pure Gamow-Teller transitions ($\Delta I = 1$). The multipolarities of all five γ rays are given. (auth)

38179 ENERGY LOSS OF ELECTRONS IN ALUMINUM IN THE ENERGY RANGE 20 TO 60 Mev. Hans Breuer (Technische Hochschule, Darmstadt, Ger.). Z. Physik, 180: 209-18(1964). (In German)

The energy spectrum of nearly monoenergetic electrons (energy width about 0.3%) was measured with a spectrometer of high resolution (about 0.1%) before and after passing through aluminum absorbers of thicknesses between 0.08 and 5.4 g/cm^2. The experiments were performed with the energy-analyzed beam of the linear accelerator; the energy was varied between 20 and 60 Mev. The most probable energy losses agree with the theory of Sternheimer within the error limits (1.5−2%) for thicknesses smaller than 2 g/cm^2. The half widths are systematically larger than the values calculated by Blunck and Westphal. (auth)

38180 TABLITSY SOSTAVA PRODUKTOV MGNOVENNOGO DELENIYA U^{235}, U^{238} i Pu^{239}. (Tables of the Products from Spontaneous Fission of ^{235}U, ^{238}U and ^{239}Pu). M. P. Grechushkina. Moscow, Atomizdat, 1964. 67p.

Tables are presented showing the activity of isotopes formed from ^{235}U by fission and thermal neutrons, from ^{239}Pu by fission neutrons, and from ^{238}U by fission and 14-Mev neutrons at decay times of from 1 hr to 100 years. Both absolute and percent of total values are given. Isotopes with mass numbers from 72 to 81 and from 157 to 166 are not included because of their very low yield. Decay schemes are shown for elements of mass number 72 to 166. (IIC-MG)

38181 STATUS OF KNOWLEDGE OF THE FINE-STRUCTURE CONSTANT, PARTICULARLY AS IT RELATES TO PROTON STRUCTURE. Vernon W. Hughes (Yale Univ., New Haven). p.235-44 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

Techniques and relations for determining the fine structure constant are discussed. Calculations of the hfs intervals of hydrogen and muonium in the ground state and of the fine structure intervals in the 2^3P state of helium are compared with experimental values. The hfs interval is also briefly considered. The value $\alpha^{-1} = 137.0387 \pm 0.0010$ obtained by combining values derived from the fine structure of deuterium and the hfs of muonium is recommended. (D.C.W.)

38182 THE CONSERVED VECTOR CURRENT THEORY AND FORM FACTORS. C. S. Wu (Columbia Univ., New York). p.245-56 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

The analogy between electrodynamics and vector beta interactions is outlined, together with the relation of the isovector weak interaction form factors to the isovector electromagnetic form factors in the conserved vector current (CVC) theory. Two experiments supporting the CVC theory and an experiment supporting the existence of two neutrinos are then reviewed. (D.C.W.)

38183 AN ANALYSIS OF TRITIUM AND HELIUM-3 FORM FACTORS. L. I. Schiff, H. Collard, R. Hofstadter, A. Johansson, and M. R. Yearian (Stanford Univ., Calif.). p.385-6 of "Nucleon Structure." Stanford, Calif., Stanford University Press, 1964.

A model used to analyze electron elastic scattering by helium-3 and tritium is summarized, and the form factors obtained are given. (D.C.W.)

38184 A STUDY OF TRANSITIONS BETWEEN THE EXCITED LEVELS OF Re^{187} FOLLOWING THE BETA DECAY OF W^{187} WITH A DETERMINATION OF K/L + M RATIOS FOR THE 134, 479, AND 618 Kev TRANSITIONS. Richard Nicholas Yasko. Thesis, University Park, Penna., Pennsylvania State Univ., 1963. 100p.

Determinations of several K/L + M conversion coefficient ratios, beta-gamma coincidence measurements, and gamma-gamma coincidence measurements were made on radiations emitted from ^{187}Re following the decay of the ^{187}W nucleus. The study was made with the use of a shallow-diffused silicon junction beta detector. The beta-gamma coincidences were studied with the aid of a 3 in. NaI(Tl) scintillation counter in conjunction with the beta detector, and two 3 in. NaI(Tl) scintillation counters were used in the gamma-gamma coincidence study. A conventional fast-slow circuit was used in all coincidence experiments and a RIDL 400-channel analyzer was employed to record the data. Gamma transitions of 72, 134, 206, 479, 511, 552, 618, 686, 773, and 866 kev were observed. The 618- and 686-kev transitions were found to be to the ground state of ^{187}Re with no transitions occurring between the two states. The 72-kev transition was found to be in cascade with the 479-kev transition, the 552-kev transition being a crossover transition of the 72- and 479-kev transitions. The 866- and 773-kev gamma rays are believed to be ground state transitions. A 62-kev conversion electron line appearing in a beta-gamma coincidence spectrum is believed to be due to K-conversion electrons arising from a transition between a previously proposed 891 ± 9-kev level and the 773-kev level. An energy level scheme for ^{187}Re is proposed. The K/L + M ratios measured for the 134-, 479-, and 618-kev transitions were 5.2 ± 0.1, 3.8 ± 0.7, and 2.7 ± 0.7 respectively. The K/L ratios were determined by using the approximate relation K/L ~ L/M, enabling the following multipolarity assignments to the 134-, 479-, and 618-kev transitions: M1, E2 + M3, and E3 + M4 respectively. (Dissertation Abstr., 24: No. 12, Pt. 1 (June 1964))

38185 MEASUREMENTS AND INTERPRETATIONS OF BETA-GAMMA DIRECTIONAL CORRELATIONS IN As^{76}, La^{140}, AND Ga^{72}. Ross Whitted Newsome, Jr. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1963. 190p.

The $\beta-\gamma$ directional correlation coefficients were measured for the two outermost $\beta-\gamma$ cascades in ^{76}As, ^{140}La, and ^{72}Ga. Finite nuclear size effects were included in the analysis of all available data for the relevant β transitions in ^{140}La and ^{72}Ga. A detailed numerical comparison of predictions based on formulae that contain finite nuclear size effects, and corresponding formulae based on the Konopinski-Uhlenbeck approximation, shows that significant discrepancies often occur. The experimental data for ^{76}As were analyzed in the modified B_{ij} approximation A semi-quantitative comparison with the predictions obtained from elementary formulations of various nuclear model theories was made. In ^{76}As, the directional correlation coefficient for the 2.41-Mev β group in coincidence with the 0.559-Mev γ transition at ten β energies ranging from 1.33 to 2.18 Mev varied from 0.076 ± 0.005 to 0.106 ± 0.005. The correlation coefficient for the 1.75-Mev inner β group in coincidence with the 1.216-Mev γ transition for all β particles in the range 1.2 to 1.5 Mev was 0.0007 ± 0.0073. In ^{140}La, the directional correlation coefficient for the 2.18-Mev β group in coincidence with the 1.596-Mev γ transition at seven β energies ranging from 1.35 to 1.95 Mev varied from 0.066 ± 0.024 to 0.112 ± 0.009. The correlation coefficient for the next inner β group at three β energies ranging from 1.35 to 1.55 Mev varied from 0.177 ± 0.018 to 0.216 ± 0.030. In ^{72}Ga, the correlation coefficient for the 3.15-Mev β group in coincidence with the 0.835-Mev γ transition at thirteen β energies ranging from 2.30 to 2.92 Mev varied from −0.320 ± 0.025 to −0.367 ± 0.014. The integral correlation coefficient for the next inner β group for all β particles in the energy range from 2.0 to 2.53 Mev was −0.263 ± 0.015. (A.G.W.)

38186 ABSOLUTE DIFFERENTIAL CROSS SECTIONS FOR THE PHOTOPRODUCTION OF POSITIVE PI MESONS IN HYDROGEN. Lorne Bruce Mortara. Thesis, Lafayette, Ind., Purdue Univ., 1963. 58p.

The absolute differential cross sections for photoproduction of positive pions from hydrogen were determined for three values of the pion energy and for eight angles for two of the energies and six angles for the third pion energy. The pion energies are 44.8, 58.3, and 71.0 Mev. The angles were chosen in the range between 22 and 135° in the laboratory for the lower two pion energies and between 22° and 98° for the highest energy. The statistical accuracy is two percent and the rest of the experimental errors combined are less than five percent. The results are compared with the theoretical predictions of Chew, Goldberger, Low, and Nambu, of McKinley, of Schmidt, and of Finkler. Care is taken to use the same phase shifts and other input data in evaluation of the various theoretical predictions where this freedom is possible. On the basis of the experimental evidence presented here no prediction of the strength of the γ-3π interaction can be made. (Dissertation Abstr., 24: No. 12, Pt. I (June 1964))

38187 SPIN-ORBIT SPLITTING OF THE GIANT RESONANCE. Yung-Chang Lee. Thesis, College Park, Md., Univ. of Maryland, 1963. 69p.

The structure of the giant resonance is analyzed in terms of the spin-orbit coupling strength parameter, λ. Detailed shell model calculations are carried out for the closed shell nuclei ^{16}O and ^{40}Ca which serve to exhibit the collective effect of the nucleons in the core. Perturbation approach using pure j-j and L-S configurations as zeroth order wave functions is employed to diagonalize the hamiltonian matrix. It is shown that the giant resonance structure depends on where the top two levels come close to each other as λ is varied from zero to unity. From this point of view, it can be argued that in general, heavier nuclei should show less structure than the lighter ones. The effect of the finite-rangedness of the nuclear force on the giant resonance is also discussed. (Dissertation Abstr., 24: No. 12, Pt. I (June 1964))

38188 INTERNAL CONVERSION COEFFICIENTS IN THE DECAY OF Hg^{203}, Cs^{137}, Au^{198}, Sn^{113} AND Hf^{180m}. Bernard Claude Levrat. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1963. 79p.

A new method of measuring the coefficients of internal conversion is described. Using $\alpha_K^{Hg^{203}} = 0.163$, the value of the internal conversion coefficient of the 661-kev transition following the decay of ^{137}Cs is measured to be 0.0933 ± 0.020. This value is then used as a standard in the study of the internal conversion coefficients in the decay of ^{198}Au, ^{113}Sn and ^{180m}Hf. Chapter II presents the present state of the theory of internal conversion coefficients. Chapters III and IV describe the equipment and methods used to analyze both the gamma and the beta spectrum of the radioisotopes. Chapter V is an analysis of the results and a comparison with the values quoted in the literature and with the theoretical values. A new value is proposed for the total conversion coefficient of ^{113}Sn: $e/\gamma = 0.477 \pm 0.025$. Several E2 transitions were studied. For ^{198}Au, the value of the K conversion coefficient is confirmed to be 0.0276 ± 0.0005, 10% lower than the value predicted by the theory. In ^{180m}Hf, the values of the conversion coefficients for the transitions 215.25 kev, 332.5 kev, and 443.8 kev were found to be respectively 0.135 ± 0.008, 0.048 ± 0.004, 0.027 ± 0.005. The L + M conversion coefficient of the 93.3-kev transition was determined to be $\alpha_{L+M} = 3.57 \pm 0.50$. The method itself could be improved by using a 3-in. × 3-in. NaI(Tl) crystal on which more data are available. The accuracy in the determination of internal conversion coefficients would then be of the order of 1% plus whatever uncertainty is involved in the measurement of the relative intensities of the conversion lines. (A.G.W.)

38189 ASYMMETRY IN THE $Li^7(p,\alpha)He^4$ REACTION PRODUCED BY POLARIZED PROTONS. Robert Allen Lux. Thesis, Madison, Wis., Univ. of Wisconsin, 1963. 71p.

The right-left asymmetry in the α-particle yield from the $^7Li(p,\alpha)^4He$ reaction produced by polarized protons was measured at a laboratory angle of 128° at twelve energies between 0.39 and 2.7 Mev. Polarized protons of energies below 1.1 Mev were produced by scattering an unpolarized beam of protons from helium. At higher energies scattering from carbon produced the polarization. The quantity measured was the ratio of counting rates in two counters located respectively at $\theta = 128°$, $\varphi = 0°$ and $\theta = 128°$, $\varphi = 180°$; φ being measured from the plane of the scattering which produces the polarization. The experimental asymmetry reaches a maximum of −0.42 at 2 Mev and decreases slowly towards both higher and lower energies. The results are in fair agreement with previous measurements. The relative cross section at 90° and the angular distribution as a function of energy were measured. The 90° cross section was measured at 20-kev intervals from 0.4 to 3.3 Mev. Angular distributions were measured at 200-kev intervals from 0.6 to 3.2 Mev. The distributions were fitted by a power series expansion in even powers of cos θ. In this energy range the coefficients of $\cos^6\theta$ and higher terms were found to be zero. It is proposed that these measurements may be explained by three resonances, corresponding to

levels in the ^{8}Be compound nucleus. (Dissertation Abstr., 24: No. 12, Pt. I (June 1964))

38190 EXPERIMENTS WITH POSITRONS FROM V^{48}. Raj Gopal Mendiratta. Thesis, University Park, Penna., Pennsylvania State Univ., 1963. 71p.

A study of positron Bhabha scattering from a magnetized Vicalloy (an alloy of iron, cobalt, and vanadium) strip 0.0001 inches thick was made. The scattering was studied in an automatic Wilson cloud chamber of about 10 inches diameter. The flash bulbs illuminated only a thin horizontal plane in the chamber and so only one camera just above the chamber was sufficient for photographic purposes. A transverse magnetic field was applied using electromagnetic coils to measure the momentum of positron tracks. Photographs were carefully scanned to identify Bhabha events (positron-electron collisions). To measure the polarization of positrons, Bhabha scattering was first studied with the spins of the positron and target electrons in the magnetized strip parallel and then antiparallel. From the number of Bhabha events observed in these two different cases, the polarization of positrons was estimated. The number of Bhabha events produced by positrons from ^{48}V in a total track length of about 2.41 centimeters in Vicalloy was 149 ± 12. The corresponding theoretical value as predicted by Bhabha theory taking into account the exchange effects is 138. The agreement between the experimental and theoretical value supports the existence of exchange effects in positron-electron scattering as first suggested by Bhabha. (A.G.W.)

38191 HIGH ENERGY PHOTONUCLEAR PROCESSES IN O^{16}, F^{19}, Ca^{40}, AND V^{51}. Richard Adlin Meyer. Thesis, Urbana, Ill., Univ. of Illinois, 1963. 172p.

Yields for several photonuclear reactions in ^{16}O, ^{19}F, ^{40}Ca, and ^{51}V were measured from their thresholds to 300 Mev using bremsstrahlung from the University of Illinois 300-Mev betatron. The reaction yields were determined by investigation of the radioactivities of the product nuclei by gamma spectroscopy techniques. The cross sections above 150 Mev for these reactions were compared with cross sections calculated for a reaction mechanism in which the primary step is the photoproduction of a meson at a single nucleon. The results of this comparison indicate that the main features of high-energy photonuclear reactions can be accounted for in terms of such a mechanism. In the case of relatively simple reactions in which only a few nucleons are emitted, the produced meson escapes and the recoil nucleon is responsible for the emission of other particles. For the more complex reactions in which more than four nucleons are emitted, meson reabsorption appears to play a significant role. (Dissertation Abstr., 24: No. 12, Pt. I (June 1964))

38192 NEW RESONANCES IN PHOTON TRANSITION STRENGTH FUNCTIONS BELOW NEUTRON THRESHOLDS IN ZIRCONIUM AND TIN. Kong Ki Min. Thesis, Urbana, Ill., Univ. of Illinois, 1963. 132p.

The measurement of quasielastic scattering cross sections of monochromatic gamma rays below the neutron threshold in zirconium and tin is described. The experimental results show that for both target nuclei, the scattering cross sections consist of several resonances with full widths at half maximum of a few hundred kev. Arguments are given to attribute these resonances to the fluctuations of the photon transition strength function, $\overline{\Gamma}_{\gamma}/D$. The competition effects from the neutron emission and the inelastic scattering are shown to play only a minor role in the observed resonances. The photon transition strengths implied by the present scattering data can be adequately explained by E1 transition in the sense of a low-energy extrapolation of the E1 giant resonance of the Lorentz shape. The theoretical estimates of the transition strengths for the E2 and M1 collective states are shown to be insufficient to account for all of the observed scattering data. The observed scattering is then predominantly due to E1 transition with some E2 and M1 mixtures. The widths of the observed resonances are compared with the imaginary part of the optical potential, W, as determined from the observed energy distribution of the excited states in (d,p) reactions and with the value W = 3 Mev often used for interpreting slow-neutron experiments. The spreading widths of the photon transition strength function implied by the scattering data are shown to be much smaller than these estimates, and several possible explanations of the discrepancy are given. (Dissertation Abstr., 24: No. 12, Pt. I (June 1964))

38193 $Zr^{90}(d,p)Zr^{91}$ STRIPPING USING THE DISTORTED WAVE BORN APPROXIMATION. Charles Edward Brient. Thesis, Austin, Tex., Univ. of Texas, 1963. 51p.

The angular distribution of the ^{90}Zr(d,p)^{91}Zr ground state and 1.215-Mev level was measured at E_d = 2.77 Mev and E_d = 3.47 Mev. The stripping corresponds to captured neutron angular momenta of $l_n = 2$ and $l_n = 0$ respectively. These momenta are in agreement with $2d_{\frac{5}{2}}$ and $3s_{\frac{1}{2}}$ assignments for the 51st neutron to the ground state and 1.215-Mev level respectively. Excitation functions for the two levels were measured from E = 2.5 to 3.3 Mev at $\theta = 140°$. The ratio of the ground state to 1.215-Mev level at E_d = 2.77 Mev is correct as predicted by the stripping amplitude. The cross section at the maximum $\theta = 40°$ for the ground state was 5.9 ± 0.6 μbarns/steradian and at the maximum for the excited state 8.8 ± 0.6 μbarns/steradian. The angular distributions obtained were fitted with distorted wave Born approximation stripping amplitudes as a test of the optical model parameters associated with a Woods-Saxon optical potential plus the coulomb potential of a homogeneous volume charged sphere. (Dissertation Abstr., 24: No. 12, Pt. I (June 1964))

38194 2.95 Mev AND 14.8 Mev NEUTRON-INDUCED FISSION OF Th^{232}. Knox McLeod Broom, Jr. Thesis, Fayetteville, Ark., Univ. of Arkansas, 1963. 108p.

Neutron-induced fission of ^{232}Th was studied at incident neutron energies of 2.95 ± 0.08 and 14.8 ± 0.2 Mev. Cumulative mass yields were measured by radiochemical techniques. Good agreement was noted between the above data and yields reported by other investigators for neutron-induced fission of ^{232}Th at similar neutron energies. Effects generally noted in the mass-yield curves for other fission reactions were observed in the present investigation. Also, fine structure was observed in the mass region A = 131–135 for both 2.95 and 14.8-Mev neutron fission. The fine structure exhibited a peak at A = 134 similar to the effect reported for ^{235}U, ^{242}Cm, and ^{252}Cf. Attempts were made at explaining the observed fine structure based on two methods. The method proposed by Glendenin gave poor agreement with the observed fine structure but the method suggested by Pappas accounted for the fine structure rather well, especially after corrections were applied for the increasing stability with increasing mass number for isotonic nuclides. Also speculations were made concerning the role of fission yield fine structure in the early history of the earth based on the terrestrial abundance data for the isotopes of xenon. (Dissertation Abstr., 24: No. 12, Pt. I (June 1964))

38195 NEW GAMMA RAYS FROM Au^{197}. Paul Burch Griesacker. Thesis, University Park, Penna., Pennsylvania State Univ., 1963. 83p.

New gamma-rays are found in ^{197}Au from electron decay of ^{197m}Pt prepared by fast neutron capture in ^{196}Pt. The 113-, 124- and 155-kev transitions are assigned to a 155-kev excited state of ^{197}Au and transitions to that state from the 268- and 279-kev levels of ^{197}Au previously reported. The assignment of these new gamma transitions to ^{197}Au is established through gamma-gamma and beta-gamma coincidence measurements along with half-life considerations. The predominance of the 268- and 202-kev transitions over the 279- and 191-kev transitions is attributed to the electron decay of the 347-kev isomeric state of ^{197}Pt to the 268- and 279-kev levels of ^{197}Au in excess of the ground state electron decay of platinum to those levels. (Dissertation Abstr., 24: No. 12, Pt. I (June 1964))

38196 THE RECOIL MOMENTUM DISTRIBUTION IN HIGH-ENERGY ELECTRON TRIPLET PRODUCTION. Charles Kaufman. Thesis, University Park, Penna., Pennsylvania State Univ., 1963. 55p.

The recoil momentum distribution in high-energy triplet production is calculated, in the region of momentum where the initial atomic binding of the recoil electron affects the distribution. The method of Wheeler and Lamb is used, with the final state specified to be an outgoing electron and an ionized atom. The cross section as a function of the momentum of this outgoing electron is the recoil distribution. The effect of representing the recoil electron by a Coulomb wave function is investigated. The approximations used are valid for recoil momenta much less than mc. Explicit recoil distributions are given for triplet production in hydrogen at several photon energies from 84 to 2000 mc^2, for triplet production in boron at 1 Bev photon energy, and for triplet production at 1 Bev in the field of a 1s electron in He, Li, and Be. (Dissertation Abstr., 24: No. 12, Pt. I (June 1964))

38197 NUCLEAR DOUBLE RESONANCE. Fred Marcus Lurie. Thesis, Urbana, Ill., Univ. of Illinois, 1963. 170p.

A new method of nuclear double resonance, which has increased sensitivity over conventional resonance techniques, is investigated both theoretically and experimentally. The technique, originally proposed by Hahn, is based on the observation that two nuclear species, with gyromagnetic ratios γ_A and γ_B, in a solid will couple strongly to each other if they are simultaneously irradiated with alternating magnetic fields $(H_1)_A$ and $(H_1)_B$ at their respective resonance frequencies and if the magnitudes of the fields are adjusted such that $\gamma_A(H_1)_A = \gamma_B(H_1)_B$. If one of the nuclear species is abundant and has a strong resonance signal, the presence of a dilute nuclear system can be detected by observing its effect on the resonance of the abundant nuclear system. Double resonance is observed by preparing the two nuclear species in states that correspond to different spin temperatures in a suitably chosen reference frame. Thermal contact between the two species is then established, and the two spin systems come to equilibrium at a common spin temperature through cross-relaxation. A simple thermodynamic theory of the double resonance process is developed, which rigorously includes the effects of the local fields. The theory is based on Redfield's hypothesis of a spin temperature in the rotating reference frame and extends Redfield's ideas to the case of a common spin temperature in two reference frames, simultaneously rotating at different frequencies. Experiments on the two isotopes of metallic lithium, ^{7}Li (92.6 percent abundant) and ^{6}Li (7.4 percent abundant), which demonstrate quantitative agreement with the theoretical formulas are described. The experimental results further demonstrate that the magnitudes of the two alternating fields are not critical and that the number of dilute nuclei in the solid can be determined. The experimental procedure and the apparatus are described in detail, and calculations of the cross-relaxation time in the doubly rotating reference frame are presented. (Dissertation Abstr., 24: No. 12, Pt. I (June 1964))

38198 PROPERTIES OF THE $S^{32}(\gamma,np)P^{30}$ CROSS SECTION FROM 50 TO 300 Mev. James Ronald Van Hise. Thesis, Urbana, Ill., Univ. of Illinois, 1963. 139p.

The total cross section for the $^{32}S(\gamma,np)^{30}P$ reaction was measured from 50 to 300 Mev in order to investigate the mechanism of this reaction at these energies. Samples of sulfur were irradiated with the bremsstrahlung beam from the University of Illinois 300-Mev betatron and the ^{30}P annihilation radiation was measured using gamma-ray scintillation spectroscopy techniques. The resulting activation data were analyzed for the cross sections using the basic Leiss and Penfold method programmed in Fortran for machine calculations. The results above 150 Mev indicate that ^{30}P production from coincident emission of a neutron-proton pair from pseudo-deuteron absorption is relatively small compared to non-pseudo-deuteron processes leading to the emission of a neutron and a proton. A model of π meson production and escape from the nucleus followed by a nuclear cascade and evaporation is seen to agree reasonably well with the experimental results. (Dissertation Abstr., 24: No. 12, Pt. I (June 1964))

38199 THEORIES OF NUCLEAR FISSION. L. Wilets. Oxford Library of the Physical Sciences. New York, Oxford University Press, 1964. 141p. $2.90.

A brief review of fission phenomena is given. The dynamics and statistics of the liquid drop model, the adiabatic model and the statistical model are discussed. Non-adiabaticity and viscosity and slow neutron fission widths are also considered. (C.E.S.)

Plasma Physics and Thermonuclear Processes

38200 (A/CONF.28/P/297) CONTROLLED NUCLEAR FUSION AND HIGH-TEMPERATURE PLASMA PHYSICS RESEARCH IN USSR. L. A. Artsimovich (U.S.S.R.). May 1964. 32p.

The principal problems defining the trends of research at the present stage are plasma containment methods providing its stability and effective methods of plasma heating. The results of the theoretical investigation on the stability problem are given. Stability in magnetic bottles of open and closed types with constant fields and the theoretical analysis of radio-frequency field stabilizing effect were studied. A review is given of the experimental investigation of adiabatic magnetic bottles of open type, the analysis of a magnetic mirror system (ion magnetron, Ogra et al.), systems with hybrid fields providing magnetic field strength rise in all directions from the plasma area (PR-5 and other devices), the relation of containment time and plasma density and temperature, experimental investigations on closed magnetic systems, plasma heating in toroidal systems with a strong stabilizing longitudinal field (Tokomag type devices), development of magnetic mirrors based on the stellarator principle, studies on various new methods of plasma heating, the experiments on turbulent plasma heating by radio-frequency fields, experiments on magneto-acoustic and cyclotron resonance, research on plasma containment by radio-frequency fields (travelling wave, systems, devices based on dynamic stabilization concept etc.), and new results of research on plasma heating during fast pulsing processes with a large power release. (auth)

38201 (A/CONF.28/P/881) PROGRESS IN CONTROLLED FUSION AND PLASMA PHYSICS IN COUNTRIES IN THE REST OF THE WORLD (OUTSIDE EUROPE, NORTH AMERICA AND THE U.S.S.R.). C. N. Watson-Munro (Sydney. Univ.). May 1964. 14p.

While a few medium sized machines are available, the rest of the world, has concentrated its activities in conducting more basic research, which it is hoped will lead to information that will assist in the design of large controlled fusion experiments. Problems are discussed under the main headings: basic plasma physics related to the controlled fusion problem, diagnostic techniques, containment and stability problems, and plasma heating. (auth)

38202 (A/CONF.28/P/882) CONTROLLED NUCLEAR FUSION RESEARCH IN WESTERN EUROPE. A. Schlueter (Institut für Plasmaphysik, G.m.b.H., Garching, Germany). Aug. 1964. 13p.

Research accomplished or in progress at 43 institutions in Western Europe on the production of useful energy by controlled thermonuclear reactions is summarized. (N.W.R.)

38203 (AD-600542) ENHANCEMENT OF PLASMA DENSITY IN AN ARC DISCHARGE. Technical Report No. 64. A. Singh and J. E. Rowe (Michigan. Univ., Ann Arbor. Electron Physics Lab.). Feb. 1964. Contract AF33(657)-8050. 32p. (ORA-05000-10-T)

The use of an electron beam-plasma interaction scheme for the generation and/or amplification of coherent signals in the millimeter wavelength regime requires the creation of a high density stable plasma. A plasma density of approximately 10^{15} particles/cc is required to produce a plasma resonance frequency of 300 Bc. The density in an arc discharge plasma was increased using mechanical and magnetic constriction methods. A density of 7.5×10^{14} particles/cc is realized at a discharge current of 4 amperes in argon. Double Langmuir probe measurements of density and temperature in the plasma are presented for zero and finite magnetic field conditions. (auth)

38204 (ATN-64(9230)-2) EXPERIMENTAL OBSERVATIONS OF KADOMTSEV INSTABILITY IN A HIGHLY IONIZED HELIUM PLASMA. D. A. McPherson (Aerospace Corp., El Segundo, Calif.). July 31, 1964. 32p.

Experimental observations of the Kadomtsev current-convective interaction between a hydromagnetic wave and an electrical current were made using a highly ionized helium plasma to verify the theoretical analysis of Woods. According to theory, the damping of the wave should be modified by the addition of a term, the sign of which depends upon the sense of circular polarization of the wave. Data were taken to determine the dependence of this term upon electrical current, wave frequency, conductivity gradient, and wave polarization. In all instances, the experimental observations are in agreement with the theoretical predictions. (auth)

38205 (NP-14224) PRODUCTION OF HIGHLY EXCITED NEUTRAL ATOMS FOR INJECTION INTO PLASMA DEVICES. S. T. Butler and R. M. May (Sydney. Univ. School of Physics). July 1964. 28p. (TR-12)

The production of highly excited states of atomic hydrogen by charge-exchange reactions of the type $H^+ + H(1s) \rightarrow H(\text{excited}) + H^+$ is investigated, and the results are used as a basis with which to compare excited-state production of hydrogen atoms by charge-exchange in gases other than atomic hydrogen. The results are expressed in terms of the equilibrium ratio i_n/i_c, that is, the ratio of the flux of excited states with principal quantum number n to the (constant) flux of protons incident on the neutralizer. It is found that with atomic hydrogen as neutralizer, the ratio i_n/i_c has a maximum of about $0.75/n^3$ at 20 kev. For alkali atoms such as lithium and sodium the maximum value of i_n/i_c occurs at about 10 kev, being of similar magnitude to, but probably smaller than, the value for atomic hydrogen. In the case of the inert gases helium, neon, and argon, the maximum value of i_n/i_c occurs in the vicinity of 50 to 70 kev and again is of similar magnitude to, but probably slightly larger than, the maximum value for atomic hydrogen. The inert gases thus offer a number of advantages over alkali gases as neutralizers: they probably yield as large if not larger values of i_n/i_c at maximum; the maximum occurs at higher energies, so that the natural decay lengths of the excited atoms are correspondingly longer; they may be very much more easily handled experimentally. (auth)

38206 (UCRL-7721) ALFVÉN WAVES IN NONUNIFORM PLASMA. C. W. Hartman (California. Univ., Livermore. Lawrence Radiation Lab.). May 19, 1964. Contract W-7405-eng-48. 17p.

The properties of small-amplitude, torsional, hydromagnetic waves in an infinite-conductivity, plane, current sheet are described by singular "modes". Logarithmic singularity occurs at the resonance point in the layer where $\omega = \bar{k} \cdot \bar{v}_a$. Finite solutions are obtained for wave packets when a spread in frequency or wave number is present, or when the infinite-conductivity hydromagnetic assumption is relaxed. Experimental observations of local torsional waves in a hard-core pinch show azimuthal spreading and axial attenuation qualitatively consistent with the presence of magnetic shear. (auth)

38207 ANOMALOUS CYCLOTRON RADIATION FROM A PLASMA DISCHARGE. R. W. Waniek, R. T. Grannan, and D. G. Swanson (Advanced Kinetics, Inc., Costa Mesa, Calif.). Appl. Phys. Letters, 5: 89-90(Sept. 1, 1964).

Measurements of anomalously high cyclotron radiation from high-energy electrons in a transient plasma discharge are reported. A capacitor bank of 20 kv, 30 μf was discharged in a characteristic risetime of 10 μ sec with peak currents up to 90 kamp across a PIG configuration operated at a neutral pressure of 20 m torr of air. A microwave pulse of rather complex structure starts soon after the initial rise of the discharge current. The pulse has a half-width of 100-300 n sec and often displays secondary peaks. The power output from the plasma was measured as a function of magnetic field for discharge voltages from 5 to 20 kv. The results are presented for the emission centering around the X- and K-band. (C.E.S.)

38208 DETERMINATION OF NEUTRAL GAS TEMPERATURE IN A PLASMA COLUMN FROM SOUND VELOCITY MEASUREMENTS. Kenneth W. Gentle and Uno Ingard (Massachusetts Inst. of Tech., Cambridge). Appl. Phys. Letters, 5: 105-6(Sept. 1, 1964).

The gas temperature in the plasma column of an argon discharge was determined as a function of gas-flow velocity, discharge current, and gas pressure from measurements of the speed of sound. An ordinary Langmuir probe, properly biased, is a simple means for the detection of sound in a discharge. The sound speed is obtained directly from the measured travel time of a sound pulse between two such probes inserted in the plasma column. (C.E.S.)

38209 A TOROIDAL PINCH APPARATUS EQUIPPED FOR MAGNETIC FIELD PROGRAMMING. Seth Berglund (Uppsala Univ.). Arkiv Fysik, 26: 495-509(1964).

The apparatus geometry and circuit techniques are described for a large torus by which discharges with a reversed axial magnetic field configuration can be obtained.

Secondary currents up to 200 kamp and magnetic fields up to 5 kgauss are obtained. The need for a flexible discharge programming system was filled by the construction of a decade multiple pulse generator for pulse sequence control. It covers the range 0 to 999 μsec in 1 μsec steps. For monitoring purposes and input power measurements, a Hall effect multiplier was developed to a bandwidth of 200 kc/s. A few discharge characteristics and measuring curves are given. (auth)

38210 A CHARACTERISTIC OF THE TOROIDAL PINCH WITH A REVERSED FIELD. S. Berglund, S. Westerlund, and P. Nygren (Uppsala Univ.). Arkiv Fysik, 27: 17-31(1964).

The buildup and breakdown processes of a reversed field configuration in a toroidal plasma were studied within a wide range of parameter values. If the applied outer field is sufficiently strong, it has a dominating influence on the discharge as a whole. A tendency towards an outward movement of the entire plasma ring characterizes the breakdown, during which the original current channel decays and is replaced by a second one that encloses the outer magnetic field to a standard pinch configuration. (auth)

38211 GENERAL CONDITION FOR THE STABILITY OF HIGHER CORRELATION FUNCTIONS IN A PLASMA. S. V. Iordanskii and A. G. Kulikovskii. Dokl. Akad. Nauk SSSR, 156: 35-7(May-June 1964). (In Russian)

The derivation of the higher correlation functions in plasma is reviewed. Under certain conditions, the derived system was found to coincide with that previously described. The average magnetic and electric fields follow the Maxwell equations while δE and δH are derived on the basis of the Coulomb and Biot-Savart equations. The solution obtained remains valid if δE and δH are calculated by the precise formula which takes the delayed effect into account; in that case a specific term is eliminated, and a different integration method must be used for another term of the equation. Some of the solutions proposed for the equation system are more closely examined, and from the deviations from the anticipated solutions the required stability conditions are determined. (TTT)

38212 THE EFFECT OF COLLISIONS ON THE DRIFT INSTABILITY OF PLASMA WHEN THE LARMOR RADIUS OF THE IONS IS A FINITE QUANTITY. A. B. Mikhailovskii and O. P. Pogutse (Kurchatov Inst. of Atomic Energy, USSR). Dokl. Akad. Nauk SSSR, 156: 64-6(May-June 1964). (In Russian)

Because of the complexity of the collision term of the kinetic equation, the trajectory integration method which was found useful for solving kinetic plasma changes, was restricted to cases in which the collisions between particles play a subordinate role. This integration method was found to be applicable to solve the oscillation problems of the inhomogeneous plasma in which collisions are of importance, if the collision model term, given by P. L. Batnagar et al. is used. Drift instability problems of the inhomogeneous plasma may be solved by this method, as shown by an example of a low-pressure plasma, in which the Larmor radius of the particles is finite and small in comparison with the wave length, while the mean free path of the particles is shorter than the longitudinal wave length. Neglecting the ion-ion but considering the electron-ion collisions, the known equation of the collison-type drift instability is obtained. It is found that if the wave length of the perturbation is decreased, the effect of the ion-ion collisions increases, resulting in a reduction of the decrement of the drift instability and causing its stabilization. The same result may be derived starting from hydrodynamic considerations, but this method makes it possible to operate at wave lengths of the order of the Larmor radius of the particles. (TTT)

38213 THE BUNDLE INSTABILITY OF A DILUTE INHOMOGENEOUS PLASMA. V. V. Arsenin (Moscow Engineering Physics Inst.). Dokl. Akad. Nauk SSSR, 156: 766-9(June 1, 1964). (In Russian)

It is known that perturbations with a wave vector component perpendicular to the magnetic field different from zero may be unstable in a homogeneous magnetized plasma in the presence of a particle bundle, even if the velocity of the bundle is less than the thermal velocity of the particles. The instability associated with the inhomogeneity of a plasma on the edges of a particle bundle of finite width was examined, and it was found that the edges of the bundle are unstable (even when the bundle velocity is less than the thermal velocity) with respect to short wavelength perturbations, which do not oscillate in a homogeneous plasma. No limitation as to smallness can be placed on the density gradient in the transition layer so that the size of the inhomogeneity may be not only greater than but also on the order of the average Larmor radius of the ions. It is noted that these unstable oscillations are localized at the edge of the bundle as contrasted to oscillations of the bundle as a whole. (TTT)

38214 "INERTIAL" INSTABILITIES IN PLASMAS. B. Coppi (Stanford Univ., Calif.). Phys. Letters, 11: 226-8(Aug. 1, 1964).

A theory of plasma stability taking into account the effects of collisions, ion Larmor radius, and electron inertia revealed a class of inertial modes of instability driven by the local gradient of the current flowing along the magnetic field, as well as the known resistive tearing and interchange modes and an inertial tearing-like mode. The features and mechanisms of the modes are summarized. (D.C.W.)

38215 ON THE APPLICATION OF HIGH-FREQUENCY FIELDS FOR MAGNETIC TRAPS WITH CUSPED-FIELD. J. Teichmann and R. Klima (Inst. for Plasma Physics, Prague). Phys. Letters, 11: 231-3(Aug. 1, 1964).

The theoretical bases for the use of gradients of h-f electric and magnetostatic fields for injecting and sealing magnetic vessels are outlined. (D.C.W.)

38216 RADIO FREQUENCY CHARACTERISTICS OF THE PLASMA SHEATH. R. W. Gould (Institut für Plasmaphysik, Garching, Ger.). Phys. Letters, 11: 236-7(Aug. 1, 1964).

The effect of changing the electric field at the electrode was investigated. An expression for the sheath capacitance (or apparent thickness) was derived. A dissipative mechanism that becomes important when individual electrons spend an appreciable fraction of a cycle of the r-f field in the sheath region is discussed. (D.C.W.)

38217 GRAVITATIONAL INSTABILITY IN A CYLINDRICAL PLASMA IN A MAGNETIC FIELD. Tsuneo Amano (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 31: 742-53 (May 1964).

The stability of an infinitely long cylinder in its own gravitational field in the presence of a magnetic field is investigated, using the energy principle for a compressible fluid. It is shown that the system may be unstable for sufficiently long wave length perturbations in which the magnetic field lines are interchanged together with the fluid; and, as a result of the interchange, the gravitational energy of the system is lowered. The cause of the instability is shown to be a convective instability in the gravitational

field. In spiral arms of the galaxy, the growing time of this instability is estimated to be about 10^8 yr, and the corresponding wave length is 10^3 parsecs for a matter density of 2×10^{-24} g/cm^3 and a magnetic field of 10^{-5} gauss, if the matter is distributed uniformly in the cylinder. The gradient of matter distribution in the radial direction, however, tends to supress the instability. It is shown that the present observational distribution of diffused matter is well explained, if the spiral arms are now assumed to be in the marginal state against the instability. (auth)

38218 HYDROMAGNETIC LOCAL INSTABILITY IN AN AXIALLY SYMMETRIC INCOMPRESSIBLE PLASMA. Tsuneo Amano and Hiromu Momota (Nagoya Univ., Japan and Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 31: 754-64(May 1964).

Local (Suydam) instability in an axially symmetric, incompressible plasma is investigated. The growth rates of the local instability are estimated for weakly and strongly unstable configurations in which Suydam's stability condition is slightly and markedly violated, respectively. A condition is obtained under which the local instability can be suppressed by the stabilizing effect of finite Larmor radii of the ions. (D.C.W.)

38219 INVESTIGATION OF POSITIVE COLUMN INSTABILITY IN AN AXIAL MAGNETIC FIELD. A. R. Akhmedov and A. A. Zaitsev. Vestn. Mosk. Univ., Ser. III, Fiz. Astron., No. 1, 3-10(Jan.-Feb. 1964). (In Russian)

Results are given of the measurements made of a critical magnetic field for developing a helicoidal instability in a positive plasma column in a longitudinal magnetic field in the presence of a high-frequency electric field. Data are also given on the influence of the plasma column length on the critical magnetic field. (tr-auth)

38220 REACTION THERMAL CONDUCTIVITY OF HYDROGEN AND SINGLY-IONIZED HELIUM IN A CYLINDRICALLY SYMMETRICAL DISCHARGE WITH SUPERIMPOSED AXIAL MAGNETIC FIELD. R. Wienecke (Institut fur Plasmaphysik, Garching, Ger.). Z. Naturforsch., 19a: 675-9(June 1964). (In German)

The reaction thermal conductivity for transitions from neutral to ionized hydrogen and from neutral to singly-ionized helium in a cylindrical symmetrical discharge with superimposed axial magnetic field was calculated. The radial pressure which developed from diffusion of charge carriers across the magnetic field, is considered, and it is shown that the reaction thermal conductivity added to the contact conductivity is relatively strongly affected by the magnetic field. Mechanically calculated curves of the reaction thermal conductivity were reproduced for different values of magnetic induction and gas pressures outside the conductivity zone. (tr-auth)

38221 IGNITION MECHANISM OF A THETA-PINCH DISCHARGE. R. Chodura (Institut fur Plasmaphysik, Garching, Ger.). Z. Naturforsch., 19a: 679-90(June 1964). (In German)

The processes of ionization by electron collision in the time-varying magnetic field of a theta-pinch-coil are discussed. These processes are strongly dependent on the charge carrier density previously existing in the gas. At low charge carrier density, the electric field is not rotational symmetrical, and the ionization is mainly restricted to the region around the coil slits. The outer electric field is screened from the stable charge carrier density, simultaneously producing an inner space charge field resulting from unequal motion of electrons and ions. An approximate self-consistent description of the motion is given. Electrons and ions move in a radial direction for strong coupling of ion- and electron-motion, both possessing equal mass calculated from geometrical mean. The electron energy is characterized by the value, $\mu = W/|B_z|$; $B_z \sim t$ and μ a periodic function of t^2. An electron gains in its first period of motion a maximum energy on the order of magnitude of the ion drift energy. From these results, boundaries were assigned, which are in good agreement with the experimental spread of the ignition points. The case is also discussed where a static field is applied and B_z is constant, in place of the rotational field $E\varphi = \frac{1}{2}rB_z$. In this case, the critical vibration observed from rotating plasmas and similar arrangements can be explained more easily by the above described boundary energy of an electron in such a field. (L.B.S.)

38222 PRESSURE MEASUREMENT WITH PIEZOELECTRIC PROBES IN A LINEAR Z-PINCH. Klaus Buechl (Institut fur Plasmaphysik, Garching, Ger.). Z. Naturforsch., 19a: 690-6(June 1964). (In German)

The radial distribution of the dynamic and kinetic pressure in a linear Z-pinch-discharge was investigated with piezoelectric probes. The electrical signals from the probe are proportional to the momentum flux on the pressure-sensitive surface. The momentum flux is anisotropic, due to radial plasma streams during the compression and expansion of the plasma cylinder. The dynamic and kinetic pressure were determined from the momentum flux by comparing the probe measurements made in different directions. The conditions and construction of the probe necessary for both a good time resolution and high sensitivity are described. The probes have time resolutions and sensitivities of 0.6 μs and 7.7 torr/mv and 0.8 μs and 2.0 torr/mv, respectively. (auth)

38223 ELECTRODYNAMIC BEHAVIOR OF LINEAR Z-PINCHES. Heinrich Schindler (Siemens-Schuckertwerke AG, Erlangen, Ger.). Z. Naturforsch., 19a: 697-703 (June 1964). (In German)

In the linear Z-pinch, three components owing to different causes yield the resulting field strengths in the axial direction: Ea produced by the capacitor potential, Ei induced by the local periodic current density variations, and Em, which arises from the motion of the plasma in the magnetic field. They can be determined from measurements with induction coils and σ ν-probes, as long as cylindrical symmetry prevails. The electrodynamic behavior of the discharge can be described from the known dependence of the field strength on position and time. Therefore, it shows that the continuous current stream in the contracting and expanding plasma cylinder is caused by an alternating effect of the three field strength components. It also gives an explanation for the more frequently observed current, which runs counter to the collective current in the plasma and thus gives rise to eddy currents. Comparison of the velocity-conductivity distributions leads to the conclusion that the shock wave originates at the observed discharge, propagating toward the axis after the plasma has reached a few centimeters from the wall. The path of a volume element during the discharge process follows from the known velocity distribution. Thus, it is shown that only the few particles which were removed no farther than two-thirds of the vessel radius from the axis were compressed in the axial region. (tr-auth)

38224 ELECTRIC DISCHARGES IN BEAMS FROM CONDENSED HYDROGEN AND CONDENSED NITROGEN IN HIGH VACUUM. E. W. Becker and R. Klingelhoefer (Technische Hochschule, [Karlsruhe, Ger.]). Z. Naturforsch., 19a: 813-14(June 1964). (In German)

A method of producing a sharply confined plasma beam from beams of condensed hydrogen and nitrogen in a high vacuum by electric discharge is described. Results show promise for use with thin-walled plasma cylinders with large ratios of length to diameter and the possibility of compression with a θ field. (L.B.S.)

38225 MEASUREMENTS OF THE BASIC PROPERTIES AND DYNAMICS OF THERMAL CESIUM PLASMAS. James Yasuo Wada. Thesis, Los Angeles, Univ. of Southern California, 1964. 275p.

The plasma density n_+ in excess of 10^{14} ions/cm^3 was generated in a plasma column 1.26 cm in diameter and 10 cm long confined by a strong d-c magnetic field. A new and direct method was used to measure the volume recombination coefficient α of a highly ionized cesium plasma. The measured values of α and their dependence upon n_+ are in agreement with those predicted by the theory of recombination by a collisional-radiative process. The probability κ_n that a Cs^+ ion hitting a plasma emitter surface (a hot tantalum emitter) is reflected or evaporated as a neutral particle was measured. The measurements indicated that the experimental value of the κ_n of Cs^+ is substantially smaller than the theoretical value ($\kappa_n \cong 0.23$) obtained from the Saha-Langmuir equation. The resistivity of a highly ionized plasma was measured for n_+ ranging from 5×10^{11} to 6×10^{12} ions/cm^3 and for electron temperatures between 2000 and 2500°K. The measured values of resistivity were found to be in good agreement with those predicted theoretically by Spitzer and were consistent with the experimental results obtained at lower plasma densities by Rynn. The measurements of the plasma electron temperature showed that the energy transfer from fast electrons injected into a plasma to the slow electrons of this plasma takes place at a faster rate than can be explained by random scattering through collisions with ions and slow plasma electrons. An effective thermalization of the injected electrons is obtained even when collisions are negligible. The mechanism of energy transfer and thermalization in the absence of collision appears to be collective interaction between the fast injected electrons and a multiplicity mode of electrostatic plasma waves. The theory of electron-plasma wave interactions leads to predictions which are in good agreement with the measured noise spectrum in and out of the plasma and explains the thermalization of fast electrons in collisionless plasmas. (A.G.W.)

38226 A SPECTROSCOPIC STUDY OF THE ARGON PLASMAS GENERATED IN A CONICAL TYPE ELECTROMAGNETIC SHOCK TUBE. John Alexander Thornton. Thesis, Evanston, Ill., Northwestern Univ., 1963. 421p.

The published reports of experimental and analytical work on electric and electromagnetic shock tubes are critically reviewed and evaluated. It is concluded that many of the characteristics of the electromagnetic shock tube can be explained with a classical diaphragm shock tube formalism in which the driver gas is assumed to be a low-density plasma with a thermally generated pressure. Furthermore it is concluded that the state of the accelerated plasma must be determined experimentally. Experiments are described in which the thermodynamic state throughout much of the slug of accelerated plasma generated in a conical type 3-inch ID electromagnetic shock tube is determined from time-integrated and time-resolved spectroscopic observations. Argon was used as a test gas. The electron temperature, atom, ion, and electron densities were calculated by the two-line method. The electron densities were also calculated from the intensity of the continuum and Stark broadening of the hydrogen H_β impurity line. The data indicated thermodynamic equilibrium in the region near the luminous front. There were indications of a high impurity level, particularly to the rear of the luminous zone. In all tests the temperatures were significantly higher than those predicted by the shock equations assuming a cold gas ahead of the luminous front. It is concluded that luminosity of the kind observed is from the driver plasma or a mixture of the driver and driven plasmas depending on the ambient pressure. An investigation using X-band microwaves indicated that the precursor electron density ahead of the shock front was less than 5×10^{10} cm^{-3}. (Dissertation Abstr., 24: No. 12, Pt. I (June 1964))

38227 EQUILIBRIUM THERMODYNAMIC PROPERTIES OF MULTIPLY IONIZED MULTICOMPONENT PLASMAS. Adolf R. Hochstim and Robert W. Terhune (General Dynamics Astronautics, San Diego, Calif.). p.155-84 of "Kinetics, Equilibria, and Performance of High-Temperature Systems." New York, Gordon and Breach Science Publishers, 1963.

Ideal high temperature thermodynamic properties for multicomponent plasmas in closed form are derived, and through an iteration method Debye-Hückel corrections are included. Concentrations of various ions are obtained for a set of Saha-type equilibrium relations by specifying temperature and electron concentration. As an illustration, tables of the thermodynamic properties and composition of argon plasmas were computed up to 100,000°K. (auth)

38228 PARTIALLY IONIZED GASES: TRANSPORT AND THERMODYNAMIC PROPERTIES. Charles W. Baulknight (General Electric Co., King of Prussia, Penna.). p.349-67 of "Kinetics, Equilibria, and Performance of High-Temperature Systems." New York, Gordon and Breach Science Publishers, 1963.

The thermodynamic properties of dissociated and partially ionized gases were computed ($300 < T < 35{,}000$°K), and comparisons were made where possible between the data and the data currently available. The necessary equations which may be utilized in the predictions of transport properties are discussed. (auth)

38229 PHYSICO-CHEMICAL DIAGNOSTICS OF PLASMAS. Proceedings of the Fifth Biennial Gas Dynamics Symposium. Thomas P. Anderson, Robert W. Springer, and Richard C. Warder, Jr., eds. Evanston, Ill., Northwestern University Press, Aug. 1963. 448p. $15.00.

The topics discussed include plasma diagnostic techniques, shock tubes, thermodynamic properties of argon plasma, electrostatic plasma probes, characteristics of a Langmuir probe, MHD turbulence, radiofrequency diagnostics, spectroscopic measurements, hypersonic waves, spectroradiometer for radiation environment of reentry vehicle, crossed-field plasma accelerators, optical interferometry, microwave diagnostics, constricted-arc discharge in supersonic nozzle, Hall currents for steady axial discharges in radial magnetic fields, momentum transfer in plasma, MHD power generation, microwave measurements of electromagnetic properties of plasma flow-fields, instrumentation for reentry plasma sheath, x-ray densitometers for plasma, and ionization profiles in low-pressure exhausts. Separate abstracts are prepared for 3 of the 21 papers presented. Abstracts of 16 papers previously appeared in NSA (17: 39813, 40152, 40202 through 40214, and 41664). (C.E.S.)

For abstracts of individual papers see: 38230, 38231, and 38232.

38230 ELECTROSTATIC PLASMA PROBES. J. H. de Leeuw (Univ. of Toronto). p.65-95 of "Physico-Chemical Diagnostics of Plasmas." Evanston, Ill., Northwestern University Press, 1963.

A brief review is given of the use of electrostatic probes for the measurement of plasma properties. A central problem is the theoretical interpretation of the measured probe characteristic. The available treatments for a variety of plasma conditions are discussed. In addition, the sources of error and the practical form and arrangement of probes are considered. (auth)

38231 MOMENTUM TRANSFER TO PLASMAS BY LORENTZ FORCES. Sterge T. Demetriades (Rocket Power, Inc., Pasadena, Calif.). p.297-328 of "Physico-Chemical Diagnostics of Plasmas." Evanston, Ill., Northwestern University Press, 1963.

A theoretical and experimental study of momentum transfer to plasmas by Lorentz forces is described. A generalized Ohm's law is used to predict changes in the direction and magnitude of the momentum of a stream of plasma and other observable macroscopic effects in a crossed-field accelerator in terms of species temperatures and concentrations and other plasma parameters. The assumption of local thermal equilibrium is not required in this approach. Measurements of momentum change and other effects are presented that are substantially in agreement with theory. Gross mean estimates of the plasma parameters in the cross-arc region are obtained from the measured momentum changes and power input. (auth)

38232 X-RAY DENSITOMETER FOR USE IN PLASMA STREAMS. Boris Ragent (Itek Corp., Palo Alto, Calif.). p.403-21 of "Physico-Chemical Diagnostics of Plasma." Evanston, Ill., Northwestern University Press, 1963.

An instrument was constructed for the measurement of the mass density of a gas in a localized volume element. The density measurement is independent of the thermodynamic or hydrodynamic state of the gas and independent of the presence of equilibrium or transient flow conditions. The instrument is especially designed for application to density measurements in high-temperature gas streams. The principle of operation involves the measurement of the scattering of a beam of moderately hard x rays to establish the number of scattering centers present in a scattering volume. This volume is defined by the geometrical intersection of a well-defined pencil of x rays and collimated viewing paths of detectors. The x-ray energy utilized is high enough so that the scattering is primarily incoherent from electrons, both bound and free, so that the number of x rays scattered into a detector per unit time is proportional only to the total electron density in the gas and not the chemical state of the gas. The gas mass density may be related to the total electron density since the number of electrons per gram is approximately constant for all common gases except hydrogen. Sample calibration data taken in helium and air are shown and typical applications are discussed. (auth)

38233 PLASMA CONFINING DEVICE. Jean-Michel Dolique (to Compagnie Generale de Telegraphie Sans Fil). U. S. Patent 3,143,477. Aug. 4, 1964. Priority date June 2, 1959, France.

A plasma-confining device, comprising an annular vessel with a number of magnetic mirrors, is designed for improved tightness of the throats of the magnetic bottles. This improved tightness is accomplished by means of a pattern of standing transverse hydromagnetic waves (Alfven waves) with its antinodes situated at the mirrors. The waves increase the transverse component of the velocity vector of the plasma particles so that their escape across the throats of the magnetic bottles is reduced. (D.L.C.)

Shielding

Refer also to abstract 38283.

38234 (A/CONF.28/P/363) METHODS OF SOLUTION OF TRANSPORT EQUATION IN INHOMOGENEOUS AND FINITE MEDIA. S. M. Ermakov, B. A. Efimenko, V. G. Zolotuchin, F. F. Michajlus, Sh. S. Nickolajshvili, and V. P. Polivanskii (U.S.S.R.). May 1964. 15p.

Finite difference methods of solution of plane-parallel and spherical-symmetric γ and neutron transport problems in hydrogenous media are discussed. Some methods for the improvement of the statistical efficiency of Monte-Carlo methods for the case of radiation transport problems in inhomogeneous and finite media are considered. A Monte-Carlo study is made of neutron penetration through the resonance absorber slab. (auth)

38235 (A/CONF.28/P/657) USE OF RESPONSE MATRIX METHOD FOR MULTILAYER SHIELD DESIGN. Iwao Kataoka (Japan. Ship Research Inst., Tokyo). May 1964. 15p.

A method for computing the transmission and reflection of gamma rays in multilayer slab shields is presented. The method is based on the fact that the transmission and reflection behavior of radiations in a barrier can be expressed by an operator, a matrix in this case. (auth)

38236 (A/CONF.28/P/684) A NEW SHIELD DESIGN METHOD AND SOME ATTENUATION STUDIES IN LAMINATED BIOLOGICAL SHIELDS. E. Aalto, L. Hjaerne (Aktiebolaget Atomenergi, Stockholm), and M. Leimdoerfer. May 1964. 15p.

A computer method has been developed to calculate the penetration of neutrons and gamma-rays through bulk shields. The attenuation and slowing-down of neutrons is treated by a combination of first-flight removal and multigroup-diffusion theories. The energy-dependent flux of such fission neutrons which are uncollided or have suffered only small-angle collisions is calculated throughout the shield; this flux provides source terms in a series of multigroup diffusion equations. Slowing-down between the diffusion groups is treated by a discrete-collision formalism in which the correct average energy loss of a neutron in a specific energy group is taken into account. Inelastic scattering and moderation by light nuclei come in naturally as slowing-down between all groups is permitted. The transport of gamma radiation born in the reactor core and in the shield is calculated with a Monte Carlo scheme employing various variance reducing techniques, e. g. the exponential transformation whereby the outward directed motion of photons is enhanced and the slope of the source distribution is modified to be more favorable for Monte Carlo treatment. (auth)

38237 (KAPL-M-6159) SOSH 1—A COMPUTER PROGRAM FOR SHIELDING CALCULATIONS. M. S. Pendergast, Jr. (Knolls Atomic Power Lab., Schenectady, N. Y.). May 14, 1964. Contract W-31-109-eng-52. 18p.

The purpose of the SOSH 1 computer program is that of calculating the neutron flux at point P (an ion chamber) due to many neutron sources distributed so as to approximate a reactor core. The use of the program is mainly in relative matters, instead of absolute matters; i.e., determining the ion chamber sensitivity to water temperature, location of the ion chamber, and location of discrete neutron sources within the reactor. Also, the contribution to the

ion chamber flux from various regions of the reactor core is of interest. The program was written in FORTRAN. (auth)

38238 (KAPL-M-6160) SOSH 2—A COMPUTER PROGRAM FOR SHIELDING CALCULATIONS (A REVISION AND EXTENSION OF SOSH 1). M. S. Pendergast, Jr. (Knolls Atomic Power Lab., Schenectady, N. Y.). May 14, 1964. Contract W-31-109-eng-52. 22p.

The purpose of the SOSH 2 computer program is that of calculating the neutron flux at point P (an ion chamber) due to many neutron sources distributed so as to approximate a reactor core. The use of the program is mainly in relative matters, instead of absolute matters; i.e., determining the ion chamber sensitivity to water temperature, location of the ion chamber, and location of discrete neutron sources within the reactor. Also, the contribution to the ion chamber flux from various regions of the reactor core is of interest. SOSH 2, unlike SOSH 1, allows for fuel cells which are not parallel to the reactor centerline and for a variable water density in the axial direction in the outer reflector. The program was written in FORTRAN. (auth)

38239 (NP-14172) SUR L'ABSORPTION DES RAYONS BETAS PAR LES ECRANS DE GRANDE EPAISSEUR. (Absorption of Beta Rays by Screens of Great Thickness). Maurice Scemama (France. Centre National de la Recherche Scientifique, Paris). June 27, 1959. 102p.

Thesis submitted to Universite, Paris.

The results obtained previously in the study of the absorption of β rays were reviewed. An attempt was made by various methods to show the actual existence of an exponential absorption law for the radiation of RaE, regardless of the type of detector used. The results obtained were compared with those from ^{32}P and ^{14}C. The properties of the residual radiation (bremsstrahlung) after absorption by a large quantity of matter were examined, and the generator mechanism of this radiation was described. The results obtained and the effects observed in the attempt to reconcile the experimental and theoretical data are discussed. (tr-auth)

38240 (TO-B-64-44) TRANSMISSION OF GAMMA RADIATION THROUGH THIN, FINITE SLABS. Matthew J. Barrett, William E. Barch, and Robert L. MacNeil (Technical Operations Research, Burlington, Mass.). May 1964. Contract OCD-OS-62-14. 47p. (AD-603414)

The shielding of gamma radiation, at photon energies where the Compton scatter process is dominant, results in a transmitted beam that is largely composed of scattered photons. An approximate formula was developed through experiment to calculate the scattered radiation and therefore determine the exact transmission, i.e., dose buildup factor (B), for thin shields in the range of photon energies from 0.6 to 2 Mev. The results of this experiment also give rise to a simple method of measuring any microscopic scattering cross section by an array of detectors without loss of the definition of the scattering angle. (auth)

38241 COMPLEX METHOD FOR CALCULATION OF DEFENCE AGAINST GAMMA-RADIATION. László Tihanyi. Energia Atomtech., 15: 259-66(June 1962). (In Hungarian)

A graphic method was previously presented by which the thickness of shield needed to protect workers against gamma-radiation could be rapidly determined. Only Pb shields were considered, requiring the use of a special factor for all other materials. This method yielded results which were not strictly valid because the characteristics of the materials with respect to the energy and activity functions differed from those of Pb. For this reason, a family of curves was developed for Fe and concrete. Altogether, 40 gamma emitters were considered. For ordinary concrete, a density of 2.35 kg/dm^3 was taken as the basis of the calculations. Special diagrams were constructed for calculating shields from materials with different densities. (TTT)

38242 SHIELD MEASUREMENTS OF THE VVR-S REACTOR. K. Faehrmann (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 267-77(1961). (In German)

The experimental arrangement for a shielding experiment in the tunnel of the thermal column of the VVR-S reactor is described and the results of the experiment are reported and discussed. A collimator and measurement tank are substituted for graphite disks in the reactor, so that a flat source 40 by 40 cm results, with a flux fine structure obtained in layers up to 40 cm thick. The results are tabulated and discussed with respect to scattered neutrons, source anisotropy, and tank dimensions. (T.R.H.)

REACTOR TECHNOLOGY

General

38243 (A/CONF.28/P/20) EXPERIENCE WITH THE CHEMISTRY OF WATER IN MODERATOR AND COOLANT SYSTEMS. H. K. Rae (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.), G. M. Allison, A. R. Bancroft, W. D. Mackintosh, J. F. Palmer, E. E. Winter, J. E. LeSurf, and S. R. Hatcher. May 1964. 10p.

The chemistry of the water systems of the NRX, NRU, and NPD reactors and of in-pile loops cooled with pressurized water, boiling water, steam–water mixtures, and superheated steam is discussed. Radolytic reactions involving water or water with components, crud transport and deposition by the coolant, and fission product release from UO_2 fuel elements are considered. (R.E.U.)

38244 (A/CONF.28/P/82) THE CONCEPT OF NUCLEAR SAFETY IN FRANCE. THE INFLUENCE OF SAFETY REQUIREMENTS ON REACTOR DESIGN. François de Vathaire, Philippe Vernier, and Adrien Pascouet (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 17p.

A review is presented of the reactor safety experience in France on the following reactor types: heavy water–gas reactors, fast neutron reactors, and water research reactors. The safety rules and their effects on the reactor designs and power limits are discussed. The corresponding safety studies are also described. (D.L.C.)

38245 (A/CONF.28/P/176) PHYSICS PROBLEMS OF WATER REACTORS MODERATED BY A VARIABLE H_2O/D_2O MIXTURE. J. Smith (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Establishment, Winfrith, Dorset, England) and F. deWaegh. May 1964. 16p.

Changes in reactivity resulting from burnup of a reactor core can be controlled by the method of variable moderation, using changing mixtures of D_2O and H_2O. This paper reports the physics investigations made in a study of small reactors operating on the pressurized water principle in which the application to marine propulsion has received some special attention. The description centers round the experimental core of 40 Mw nominal heat output which is to be installed for test purposes in the BR3 reactor at Mol, Belgium. The requirements imposed on the core design were that: it should have a long operating life; the parameters of the experimental core should be chosen so that in a power reactor core of the same basic design the shut-off rod capacity would be sufficient to maintain subcriticality even if the reactor were flooded with cold light water at the start of life; the temperature coefficient of the moderator/coolant should be sufficient to allow regulation by temperature variations over the load range from zero to full power. The principles of the physics design that has been evolved is described, in which the core is built up of an array of standard size hexagonal units, some of which contain fuel and the remainder of which are tubes filled with moderator into which the circular flux-trap type absorber rods are inserted. The methods of calculation for reactivity estimation and burnup, reactivity coefficients, shutoff rod worths and power peaking effects are described. The basis on which the selection of the proportions of moderator to fuel, and coolant to fuel were made are commented on and the relation of power peaking to power output and peak/average burnup discussed. The range of moderator compositions of interest, and the variation with core life, are reported. The core studies have been supported by an initial experimental physics program. A zero-energy program is in progress. The two subcritical assemblies and the critical system Dimple, and the techniques for the measurement of power peaking, buckling, reaction rates, and shut-off rod worths are described and results reported. The analysis of these results by methods developed for the purpose is given and a comparison is made with the design methods used. The Venus critical assembly at Mol is described and the objects of its program are given. A brief description is given of the measurements it is intended to carry out in the BR3 experiment to obtain nuclear and thermal data to aid future designs. (auth)

38246 (A/CONF.28/P/181) DEVELOPMENT OF LICENSING AND INSPECTION OF NUCLEAR INSTALLATIONS IN THE UNITED KINGDOM. T. Griffiths and R. Gausden (Gt. Brit. Ministry of Power. Inspectorate of Nuclear Installations, London). May 1964. 12p.

A discussion is presented of the experience obtained in applying the Nuclear Installations (Licensing and Insurance) Act 1959 to the reactor put into operation since 1962. Inspectorate organization, siting policy, licensing conditions, design safety assessment, inspection, reactor commissioning and operation, incidents, and reports are discussed. Some of the changes made in the regulations are outlined. (D.L.C.)

38247 (A/CONF.28/P/185) GRAPHITE OXIDATION AND REACTOR SAFETY. J. R. Beattie (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch, Risley, Lancs, England), J. B. Lewis, and R. Lind. May 1964. 15p.

The oxidation of graphite following its removal from gas-cooled reactors is studied, using air and N_2–O_2 mixtures as oxidizing agents. The implications of these results with respect to gas-cooled-reactor safety are discussed, with particular attention to accidents in which air is admitted into the cooling system. (T.F.H.)

38248 (A/CONF.28/P/186) CONTROL OF GAS-BORNE ACTIVITY ARISING FROM REACTOR FAULTS. R. D. Collins (United Kingdom Atomic Energy Authority. Reactor Group, Windscale, Cumb., England) and A. E. J. Eggleton. May 1964. 14p.

The trapping of fission products (particularly I) released by nuclear reactors during normal and abnormal conditions is studied. The various forms in which I is found are noted, and methods for trapping each are discussed. The efficiencies of the trapping systems are also discussed. (T.F.H.)

38249 (A/CONF.28/P/510) NUCLEAR CROSS SECTIONS FOR FAST REACTORS. S. Yiftah and M. Sieger (Israel. Atomic Energy Commission, Tel-Aviv). May 1964. 16p.

The 16-group YOM cross section set for fast reactor analysis is revised. A revised 16-group cross section set takes account of: new information on neutron angular distributions, modified inelastic scattering matrices necessitated by different nuclear temperatures and statistical model calculations, modified capture cross sections of the fissile nuclides, modified γ values of uranium-235, and modified cross section values. An extension of the 16-group

set to a 20-group set by adding 4 groups in the 2–14 Mev range is presented. Thus, taking into account the (n,p), (n,α) and (n,2n) reactions. A detailed study to 14 Mev will facilitate analysis of experimental results obtained with pulsed neutron sources. A finer group structure above the uranium-238 fission threshold enables study of the fine structure of the flux in this region. Another extension of the YOM set, below the present boundary of 0.5 kev, is in progress. This will enable spectrum analysis of neutrons in blankets and in Doppler calculations. (auth)

38250 (A/CONF.28/P/564) REACTOR PHYSICS RESEARCH IN UNITED KINGDOM UNIVERSITIES. W. Murgatroyd (London. Univ. Queen Mary Coll.), P. J. Grant, N. S. Grassam, M. J. Harris, J. Walker, and H. W. Wilson. May 1964. 18p.

The work being carried out and the results obtained in those British universities actively engaged in reactor physics research are summarized. The validity of using a graphite exponential assembly for control rod measurements in place of a critical system was confirmed at Imperial College (University of London). Work on neutron slowing down is progressing. Pulsed neutron measurements of diffusion parameters are being made. The 100-kw London University Reactor, Consort, will enable the effects of temperature gradients on neutron diffusion to be studied. At Queen Mary College (London University), measurements on uranium/water lattices using resonance and 1/v detectors have revealed a dependence of the measured buckling upon the type of detector used. Mean neutron lifetimes in the lattices and diffusion parameters in various hydrogenous systems were measured, using pulsed sources sources. A 10-w critical reactor, designed to study hydrogeneous systems, is under construction. A high-precision reactor oscillator was developed. Theoretical and experimental uses of stochastic reactor theory are studied. A binary stochastic oscillator was constructed. The group at Manchester University is studying pulsed source techniques for measuring diffusion parameters and absorption cross sections, giving special care to harmonic analysis. Neutron spectra measurements are being made on a natural uranium light water exponential assembly and a large graphite stack. The group is also studying the kinetics of water moderated systems, using pulsed sources and steady state measurements on voided assemblies. The Manchester-Liverpool Joint Reactor will assist this work. At Southampton University, the main research tool is a natural uranium/water sub-critical assembly, coupled to a 150-kv positive ion accelerator. The research group is interested in pulsed source techniques for measuring the buckling of an irregularly shaped core. In Scotland, reactor physics research is based on the Scottish Research Reactor Centre, at which the basic equipment is a 100-kw UTR-100 research reactor. The present research program includes the development of crystal spectrometers for neutron spectrum determination. (auth)

38251 (A/CONF.28/P/635) THE AQUEOUS HOMOGENEOUS SUSPENSION REACTOR PROJECT. (Keuring van Electrotechnische Materialen, N. V., Arnhem, Netherlands). May 1964. 16p.

A survey is given of the status of the development of the Aqueous Homogeneous Suspension Reactor Project. This project aims at investigating the application of aqueous oxide suspensions as reactor fuel. Some features of the experimental facility, the Kema Suspension Test Reactor (KSTR) (under construction), are presented. The design of this test reactor is based on results of the research and development program carried out during the last few years. Typical results in connection with the application of aqueous suspension fuels are reported. The experimental work has confirmed the important role of colloid chemical phenomena in the behavior of suspensions. Since this requires colloid chemical investigations at elevated temperatures (up to 250°C) a new method has been developed for this purpose. Results obtained with this method are given. Measurements on the range of fission products in UO_2 were carried out in the zero-energy assembly, leading to figures of 4.5 to 8 μ for the various isotopes. The retention of fission fragments in the fuel particles proved to be higher for a flocculating suspension than for a completely dispersed one. Activation methods have been used to determine the thermal and epithermal neutron flux distribution inside the core vessel. It was demonstrated that with a circulating suspension very stable and safe reactor operating conditions can be achieved as well as a time independent distribution of the suspension particles in the reactor vessel together with a constant overall concentration. This holds both for colloid chemically stable and unstable conditions. Some technological aspects of the KSTR are discussed. (auth)

38252 (A/CONF.28/P/644) STATIC AND DYNAMIC MEASUREMENTS ON THE DOPPLER EFFECT IN AN EXPERIMENTAL FAST REACTOR. W. Haefele (Kernforschungszentrum, Karlsruhe, Germany), K. Ott, L. Caldarola, W. Schikarski, K. P. Cohen, B. Wolfe, P. Greebler, and A. B. Reynolds. May 1964. 16p.

Design of fast power reactors is dependent upon, and strongly influenced by, a detailed understanding of the behavior of the Doppler effect under various conditions, in particular operating and accident conditions. There are principally two different tools to determine the Doppler effect in fast reactors, viz., a fast-neutron critical facility and an experimental fast reactor. The complementary potentialities of these two tools are outlined and an experimental program for the detailed examination of the Doppler effect in an experimental fast reactor is discussed. Such a program requires the use of an experimental fast reactor capable of safely undergoing both super-prompt critical and sub-prompt critical excursions. The Southwest Experimental Fast Oxide Reactor (SEFOR) has been designed specifically with this program in mind. The requirements on the reactor and its design are briefly described. The various tests are discussed in detail. Special attention is given to the physical parameters involved in the evaluation of the Doppler effect and to the precision expected of the final results. (auth)

38253 (A/CONF.28/P/695) NON-PERIODICAL LATTICE WITH OPTIMUM K_{eff} AND NEGATIVE TEMPERATURE COEFFICIENT. B. Vittoz, Ch. Mandrin, Ph. Robert, P. Gavin, and Ph. Berthet (Lausanne, Switzerland. Universite. Ecole Polytechnique. Laboratoire Genie Atomique). May 1964. 18p.

It is well known that the under-moderation necessary to obtain a negative temperature coefficient in a light water reactor is an economic waste. This inconvenience is remedied to a certain extent by the use of a multizone core. A non-periodic lattice is proposed in which the uranium rods are disposed in concentric circles. The number of rods used in each circle is chosen so as to obtain a maximum K_{eff} value with a negative temperature coefficient, the total number of rods being constant. The division into cylindrical cells characterizes this type of lattice in the following way: let circle "index k" have a radius R_k. The delimitation of cell index k will be known by the radii $(R_k + R_{k-1})/2$ and $(R_{k+1} + R_k)/2$. The coeffi-

cient of uranium concentration is g = (Uranium volume in one cell/Total volume of the cell) and this coefficient characterizes each cell. The role of one cell can be compared to the role of one zone in a multizone reactor. To study the reactivity of a lattice as a function of the spatial distribution g (r) of the concentration coefficient, we use the theory of active and passive surfaces. This method, derived from the "Small Source Theory," considers the uranium rods as surface elements. The diffusion theory applies to the pure water placed between these surface elements, while the absorbing and fissile properties of uranium are taken into account by boundary conditions. The results of experiments with a subcritical assembly using slightly enriched uranium oxyde and light water confirm the theory. The temperature coefficient is determined by experiments at 20°C and 80°C. These measurements permit the establishment of the neutron balance and the deduction of the effective multiplication coefficient. This study shows that it is possible to obtain a higher multiplication coefficient and a more uniform flux distribution in a non-periodic lattice than in a regular undermoderated lattice, all at the same time conserving a negative temperature coefficient. (auth)

38254 (A/CONF.28/P/719) SIMULATION METHODS OF TRANSIENT THERMAL PROCESSES IN GAS-COOLED REACTORS ON ANALOGUE COMPUTERS. V. B. Nesterenko and V. M. Shadsky (Akademiya Nauk Belorusskoi S.S.R., Minsk). May 1964. 19p.

A method is proposed for simulation of transient heat-transfer processes in a gas-cooled reactor on an analog computer. Partial differential equations are transformed into nonlinear differential equations that account for parameter distributions along the reactor length by expression of the integral-mean gas temperature in terms of inlet and outlet temperatures and their derivatives in the form of a series. The method is more efficient than the finite difference method of simulation. (D.C.W.)

38255 (KR-72) QUARTERLY PROGRESS REPORT, JANUARY–MARCH 1964. (Norway. Institutt for Atomenergi, Kjeller). June 1964. 58p.

A review is presented of: JEEP and NORA operations; JEEP II construction; bucklings, lattice parameters, temperature coefficients of reactivity, and neutron lifetimes in H_2O–D_2O moderated lattices; integral methods for determining thermal-neutron disadvantage factors in thermal reactors; positron annihilation in magnetized Fe single crystals; UO_2 reprocessing methods; fatigue and tensile testing of tubes of stainless steel and IFA-3 Al alloy; corrosion of mild carbon steel by water and steam; operations of Netherlands'-Norwegian radiochemical processing plants; and solvent-extraction systems for Pu purification. (T.F.H.)

38256 (RPI-75) REQUIRED SAFETY IN NUCLEAR REACTORS. G. C. Laurence (Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.). Jan. 25, 1961. Reprinted Mar. 1961, Mar. 1964. 16p. (AECL-1923)

The safety of nuclear reactors is discussed in terms of the probability in one year of an accidental release to air outside the plant fission products greater than the minimum potentially disastrous escape, which is defined for a normal distribution of population, which is also defined. The probability of a potentially disastrous escape depends on the probable rate of dangerous failures of equipment and judgment, the unreliability of protective devices, and the unreliability of containment provisions. The use of experience of three different kinds to estimate probable rate and unreliability is discussed. Permissible ineffectiveness, which is distinguished from unreliability, of protective measures is also considered. Distribution of population and restriction of use of land nearby are discussed in relation to the probability of potentially disastrous escapes. (auth)

38257 REACTOR HANDBOOK. SECOND EDITION, REVISED AND ENLARGED. VOLUME IV. ENGINEERING. Stuart McLain and John H. Martens, eds. (Argonne National Lab., Ill.). New York, Interscience Publishers, 1964. 872p. $25.40(Interscience Publishers).

Engineering aspects of reactor design and operation are discussed. Separate abstracts were prepared for each of the 21 chapters. (R.E.U.)

For abstracts of individual chapters see: 37316, 37351, 37352, 38258, 38259, 38260, 38261, 38262, 38289, 38290, 38291, 38292, 38337, 38347, 38348, 38349, 38350, 38351, 38352, 38374, and 38545.

38258 HEAT GENERATION AND THERMAL ANALYSIS. Harry E. Stevens (Knolls Atomic Power Lab., Schenectady, N. Y.). p.127-54 of "Reactor Handbook. Second Edition, Revised and Enlarged. Vol. IV. Engineering." New York, Interscience Publishers, 1964.

Some problems in heat generation and thermal analysis are discussed: steady-state heat removal, transient heat removal from the reactor core, and thermal heat generation in non-core components are considered. (R.E.U.)

38259 STRUCTURAL ANALYSIS. Lester W. Smith (Combustion Engineering, Inc., Chattanooga). p.262-306 of "Reactor Handbook. Second Edition, Revised and Enlarged. Vol. IV. Engineering." New York, Interscience Publishers, 1964.

The significance of mechanical and thermal stresses in reactor engineering and properties of reactor materials are discussed. Various industrial codes and specifications are reviewed. A bibliography of 93 references and a selected reading list are included. (R.E.U.)

38260 REACTOR OPERATIONS. W. Kelly Woods (General Electric Co., Pleasanton, Calif.). p.423-8 of "Reactor Handbook. Second Edition, Revised and Enlarged. Vol. IV. Engineering." New York, Interscience Publishers, 1964.

Reactor startup, fuel loading and discharge, and component failures are considered. (R.E.U.)

38261 REACTOR SAFETY. C. Rogers McCullough (Atomic Energy Commission, Washington, D. C.). p.429-38 of "Reactor Handbook. Second Edition, Revised and Enlarged. Vol. IV. Engineering." New York, Interscience Publishers, 1964.

Safety considerations in the location, design, construction, and operation of reactors are discussed. (R.E.U.)

38262 PLANT OPERATIONS AND SERVICES. O. H. Greager (General Electric Co., Richland, Wash.). p.445-62 of "Reactor Handbook. Second Edition, Revised and Enlarged. Vol. IV. Engineering." New York, Interscience Publishers, 1964.

Operating personnel, plant maintenance, health physics procedures, waste handling, fuel element failures, fissionable materials control, licensing procedures, and plant security considerations are discussed. (R.E.U.)

38263 CORE HANDLING IN HEAVY WATER REACTORS. Bernt Torsten Allan Hargoe and Anton Ingvar Holtz (to Aktiebolaget Atomenergi). U. S. Patent 3,143,479. Aug. 4, 1964. Priority date Dec. 7, 1959, Sweden.

A method and an apparatus are described for simplified

core handling in heavy water reactors. The method comprises the stages of drawing off the heavy water, spraying light water over the fuel elements to wash out the rest of the heavy water, filling the reactor with light water after which the core is replaced or modified, and repeating the whole spraying-filling sequence in reverse to prepare the reactor for startup. (D.L.C.)

Auxiliaries and Components

38264 (A/CONF.28/P/15) DEVELOPMENT OF ORGANIC-LIQUID COOLANTS. W. M. Campbell (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.), A. W. Boyd, D. H. Charlesworth, R. F. S. Robertson, and A. Sawatzky. May 1964. 15p.

Studies of the decomposition of organic coolants under irradiation, film deposition by organic coolants, removal of impurities from organic coolants, and hydriding of zirconium alloys by organic liquids are summarized. (D.C.W.)

38265 (A/CONF.28/P/23) DEVELOPMENT OF FUEL AND COOLANT TUBES FOR A REACTOR COOLED BY ORGANIC LIQUID. D. G. Boxall (Canadian General Electric Co., Ltd., Peterborough, Ont.), W. M. Brown, D. B. Nazzer, J. T. Roberts, R. G. Hart, and K. L. Smith. May 1964. 14p.

Development work on the UO_2 fuels required for WR-1, and on advanced coolant-tube concepts necessary for large power reactors, is described. The properties of SAP for fuel sheathing and pressure tube construction are discussed; SAP 930 and 895 containing 7 and 10% oxide, respectively, and M257 and 583 containing 7% oxide were tested. (R.E.U.)

38266 (A/CONF.28/P/53) TECHNOLOGICAL STUDIES ON ORGANIC COOLING FLUIDS. Pierre Leveque (Commissariat à l'Energie Atomique, Paris), Franco Franzetti, Pierre Van Der Venne, and Marcel Giulani. May 1964. 22p.

A technological study of the terphenyls is presented. The results obtained from the radiolysis and pyrolysis of the product OM2 (70 p. 100 m-terphenyl, 25 p. 100 o-terphenyl, 5 p. 100 p-terphenyl) are reported. Using two pile loops at temperatures up to 450°C, a phenomena of accelerated pyrolysis on the radiolyzed material was demonstrated. Some by-products of the petroleum industry were also studied, with a view to finding substitutes for terphenyl. (auth)

38267 (A/CONF.28/P/70) BEHAVIOUR OF WATER AND HEAVY WATER IN NUCLEAR REACTORS AND PROBLEMS OF POWER REGULATION BY PHYSICO-CHEMICAL METHODS. Lucien Dolle, Daniel Conan, and Grégoire Dirian (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 17p.

The use of nuclear poisons dissolved in the water of a reactor leads to its chemical pollution. The conditions under which poisons can be used without causing the undesirable effects of this pollution are studied. (auth)

38268 (A/CONF.28/P/138) GAS CIRCULATORS AND THEIR DRIVES FOR LARGE GAS-COOLED POWER REACTORS. H. Bateman, G. L. Duffett, and W. Johnson (United Power Co., Ltd., London). May 1964. 15p.

The two basic types of circulators and the many forms of drive available are investigated and discussed, together with examples of their application and the reasons for the choice. Centrifugal and axial circulators' main features are described, together with an extensive discussion on the relative merits of steam-turbine drive, fixed-speed-a.c.-electric, variable-speed-a.c.-electric, and variable-speed-d.c.-motor drive. The necessity for trouble free gas seals to prevent the escape of toxic gas from the reactor pressure circuit is stressed. The more important aspects of circulator control and the influence of safety consideration upon control philosophy are discussed. The self-cooling feature of steam-turbine-driven circulator is outlined and the incorporation and use of pony motors is discussed. Commissioning tests prior to criticality to prove mechanical soundness of the circulator machinery and freedom from vibration of pressure circuits have an influence upon the type of drive. The purpose of various tests performed at site is described. A review is included of the circulator and drive features of civil power reactors designed in the U.K., which demonstrates that development and design philosophy has naturally fallen into 3 broad stages. The first stage involved electric-motor drive and the principle of coolant gas flow control by means of speed variation, and the second stage had variable-speed steam turbines or fixed-speed electric motors with valve control of the gas flow. Monolithic concrete pressure vessels containing the reactor core, boilers and circulators currently being constructed constitute the third stage and pose new problems. The diameter and number of vessel penetrations must be minimal. Gas flow control by valving is difficult to achieve, because regulating devices would have to be within the vessel with the circulators. Flow control by speed variation has again become attractive. (auth)

38269 (A/CONF.28/P/139) EXPERIENCE WITH BRADWELL AND LATINA ON-LOAD FUEL HANDLING EQUIPMENT AND ITS INFLUENCE ON FUTURE DESIGNS. J. O. Joss (Nuclear Power Group, Knutsford, Ches., England), W. H. Shipley, G. H. Branch, and J. E. Taylor. May 1964. 15p.

The Bradwell fuel handling system is described, together with its testing, development, and performance. The improvements in the Bradwell design for the Latina facility are then summarized, along with the testing of the Latina machinery. The future modifications made for the Dungeness and Oldbury machinery are then described. The main requirements for good fuel-handling machinery are indicated, and the control of a system of the Bradwell type by a digital computer is discussed. (D.C.W.)

38270 (A/CONF.28/P/140) THE DESIGN AND CONSTRUCTION OF PRESTRESSED CONCRETE PRESSURE VESSELS WITH PARTICULAR REFERENCE TO OLDBURY NUCLEAR POWER STATION. A. Houghton Brown (Nuclear Power Group, Knutsford, Ches., England), J. D. Hay, R. B. Hyde, and T. W. Spruce. May 1964. 16p.

The development of commercial nuclear power stations in the United Kingdom which led to the adoption of prestressed concrete pressure vessels containing the whole pressure circuit for the coolant gases is reviewed. The basic design requirements are stated, and principles for structural behavior of the vessel in the elastic range and at ultimate failure are summarized. The general design for the liner and cooling system is outlined and the requirements to be met by materials and pre-stressing systems are mentioned. The interrelation of the vessel shape, pre-stressing methods, and plant arrangement is examined for spherical and cylindrical vessels; and the costs are compared. The choice of end closures and pre-stressing systems for cylinders is discussed. The design and construction of the Oldbury station are used as an example. The Oldbury vessel is briefly described, including main

dimensions and arrangement of the pre-stressing system. The methods used for elastic and ultimate analyses are outlined, as well as the design of the liner, the penetrations, the cooling system and the insulation. (auth)

38271 (A/CONF.28/P/144) INVESTIGATIONS TO PREDICT THE PERFORMANCE OF STEEL REACTOR PRESSURE CIRCUIT COMPONENTS IN SERVICE. C. H. A. Townley and E. Procter (Gt. Brit. Central Electricity Generating Board, London). May 1964. 16p.

Research of an engineering nature in the field of nuclear pressure vessels and primary coolant circuit components is considered. The problems that are concerned with the safety and integrity of the plant throughout its working life are outlined. The work so far completed in this direction is described, and a review of what still needs to be done is given. At the present time, it is generally not possible to predict, by calculation, the performance of pressure circuit components in service, especially if creep and other forms of inelastic behavior are involved. Thus, in the immediate future, the information required must come from tests on actual components and on models, carried out, where necessary, under simulated environmental conditions. The investigations discussed include: three tests beyond yield on highly stressed components – a duct corner unit, a standpipe nozzle cluster, and an intersection between a support skirt and a spherical shell, a creep test on a standpipe nozzle cluster, and two cyclic loading tests on a standpipe nozzle cluster and an intersection between a support skirt and a spherical shell. (auth)

38272 (A/CONF.28/P/180) DESIGN OF CONTROL ROD SYSTEMS FOR GAS-COOLED REACTORS. P. B. Branson, R. L. Carstairs, and A. J. Spurgin (United Power Co. Ltd., London). May 1964. 14p.

The practical application of control principles to gas-cooled graphite-moderated reactors is discussed, with particular reference to the grouping, spatial distributions, and movement rates of controlling absorbers. Both static and kinetic aspects of control are considered. Some requirements can only be expressed qualitatively, and some are conflicting, necessitating compromise. Adequate monitoring of reactor conditions is essential. Speedy and economical design analysis methods are necessary to complement fully detailed analysis methods, which are more suitable for detailed operational studies of reactor behaviour. Typical design methods suitable for static and kinetic control analysis are described. Various groupings of the coarse control rods for start-up are considered and it is shown that a four-group scheme probably provides the best arrangement. The use of automatic spatial control rods for both unison and local control is described, the opposing demands affecting movement rates are discussed, and an alternative layout to the conventional sector scheme is introduced. The merits of fixed and movable absorbers for power flattening are compared; the need to consider the spatial control and override rod groups as integral parts of the flattening and the importance of symmetry in the rod groups are emphasised. The control principles discussed above are illustrated with reference to two contrasting systems. Firstly, the Tokai design is considered; this is a relatively small reactor at an advanced stage of construction with many features common to other Stage 1 Magnox reactors. The design includes secondary shutdown to other Stage 1 Magnox reactors. The design includes secondary shutdown devices using boron balls to give increased protection against earthquake hazards. The way in which these devices, as well as the control groups and variable flattening system, are accommodated within a single grid of standpipes is described, particular attention being given to eliminating the possibility of "local criticality." Typical spatial transient behavior for the sector arrangement of controllers is illustrated and the effects of control thermocouple location relative to the rods are indicated. Secondly a new core design is considered and the control system described; this core is much larger than that of the Tokai reactor and fixed flattening is utilized. Because of the large size it is possible to extend the integration of spatial control and override rods with the flattening; this improves both the core efficiency and the automatic flattening effect of the spatial control rods. The advantages of one particular arrangement of spatial control and override rods for a large core are discussed. Results of radial-azimuthal stability studies and transients following local absorber movement are given. The likely trends in control systems for future reactors, such as the advanced gas-cooled reactor, are discussed, and include closer integration with conventional plant, better load following, and increasingly flexible operation. (auth)

38273 (A/CONF.28/P/330) CONTROL SYSTEM OF NUCLEAR REACTORS. I. Ya. Emelyanov, A. G. Philippov, S. L. Umanskaya, and A. I. Khludov (U.S.S.R.). May 1964. 19p.

The main design principles of nuclear reactor control systems are discussed. Reactor monitoring is described, beginning from the subcritical condition, by means of instruments operating from the current ionization chambers and gives the characteristics of the instruments which provide the means for the measurement of the period and power on a logarithmic and linear scale. Two systems of automatic power level control are described, one exponential with a preset period, and the other linear. The paper goes on to discuss the safety provisions, alarm system and emergency shut-down systems, the relation between the circumstances which require reactor shut-down and the means for quenching the reaction; specific features of the system for the power level overshoot control are noted. The paper shows the advantages of the actuator control schemes using transistorized elements as compared with the control schemes using relays and contactors. (T.R.H.)

38274 (A/CONF.28/P/331) HIGH-PRESSURE VESSELS OF LIGHT-WATER COOLED AND MODERATED POWER REACTORS. V. V. Stekolnikov, A. A. Khokhlatchev, V. P. Denisov, Ju. V. Vikhorev, N. I. Prigorovskii, N. A. Lugov, B. I. Kovalenko, and V. B. Dobronravov (U.S.S.R.). May 1964. 23p.

Requirements for materials used in high-pressure vessels for large water-cooled and -moderated reactors are discussed. Corrosion stability, material strength under stress and with repeated static loading, seal choice and performance, vessel performance under stresses from non-uniform temperature distribution, and serviceability of electrically welded joints from different steels are considered. (M.J.T.)

38275 (A/CONF.28/P/354) CHOICE OF SOME OPTIMUM CHARACTERISTICS FOR THE REACTOR CONTROL SYSTEM. V. V. Orlov, V. S. Andreyanov, E. I. Grishanin, L. I. Isakova, A. G. Kalashnikov, J. G. Pashkin, G. I. Toshinskii, and V. V. Chenkunov, (U.S.S.R.). May 1964. 18p.

A method is described for determination of optimum burnable absorber characteristics and the technique of distributing them over the core to flatten the shape of heat release during the reactor lifetime. Requirements for the absorption cross section of burnable isotopes and some

techniques of using burnable absorbers are formulated. A possibility of reaching zero unbalance of reactivity is discussed, based on an ideal case of infinite absorption cross section. The practical recommendations for choosing the geometry of rods are given on the basis of this analysis. As specific examples the following practically important types of burnable absorbers are investigated: homogeneous; non-large self-shielding factor; and large macroscopic absorption cross section. The method of determining optimum composition of an arbitrary mixture of resonant absorbers for control rods from the standpoint of: increasing rod efficiency; and decreasing distortions of neutron fields due to the rods, is illustrated, by an example of optimum mixture corresponding to the maximum efficiency of rods of given dimensions in intermediate reactor PF-4 ($\rho Be/\rho U = 90$). The method was used to calculate the optimum plate control rod composition for water-moderated water-cooled reactor ($\rho H/\rho U = 280$), corresponding to minimum neutron field distortions near these rods. Calculated results are compared with experimental data. (auth)

38276 (A/CONF.28/P/476) THE PRESENT STATE OF KNOWLEDGE ABOUT CADMIUM AND INDIUM TANTALATE AS POSSIBLE CONTROL MATERIALS FOR HIGH-TEMPERATURE REACTORS. F. Haessner, G. Petzow, and E. Preisler (Max-Planck-Institut fur Metallforschung, Stuttgart). May 1964. 16p.

Cadmium and indium tantalates can be used as absorber materials in high-temperature reactors. Compared with boron or boron-containing materials, which have almost exclusively been proposed for higher temperatures, the tantalates have the advantage in absorbing neutrons by an (n,γ) reaction instead of an (n,α) reaction. In relation to hafnium, the lanthanons or their oxides or other compounds, which are also interesting materials for higher temperatures, the tantalates are easily available at relatively low costs. Mixtures of cadmium and indium tantalates possess an advantageous absorption spectrum for neutrons as well in the thermal as in the epithermal region. This spectrum is comparable with that of hafnium or of the silver-indium-cadmium alloys. Furthermore the double-oxides are, with respect to tantalum, also interesting for fast reactors since only the isotope ^{10}B can compete with tantalum in that energy range (0.01 Mev to some Mev). $Cd_2Ta_2O_7$ has good thermal resistance to 1000°C, $In_2Ta_2O_8$ to 1300°C. The tantalates show no phase transformation between room temperature and 950°C (the highest temperature investigated). The double-oxides can be prepared easily by annealing the pure components CdO and Ta_2O_5 or In_2O_3 and Ta_2O_5. Cadmium tantalate is compatible with silver and copper and, up to 700°C, with nickel; indium tantalate is completely compatible with silver, copper, and nickel, and up to 700°C with molybdenum and to some degree with iron. For an estimation of the behavior of the materials under reactor conditions the daughter products that originate by neutron absorption were considered. Whereas ^{113}Cd transforms into stable ^{114}Cd, tantalum is transmuted into tungsten and indium into tin. Both daughter products can bind more oxygen in their most stable valence states than the parent elements. Therefore the reduction of Cd^{2+} to metal can be expected while indium tantalate should be stable. This was confirmed by experiments with SnO- and WO_3-additions to cadmium tantalate. Addition of copper(I) oxide to the compounds can suppress this effect. For the practical use of the tantalates, the workability of the pure compounds as well as of a cermet is of importance. While sintered pellets of the pure tantalates that were originally pressed at room temperature cannot be shaped by plastic deformation, there is no difficulty in deforming tantalate-copper cermets in a suitable can up to high degrees. Even after high degrees of deformation the distribution of the tantalate particles remains even, no clustering occurs. This even distribution is not disturbed by a recrystallization treatment of the deformed cermet. Investigations of the behavior of the tantalates under reactor conditions were initiated. (auth)

38277 (A/CONF.28/P/519) HEAT TRANSFER CHARACTERISTICS OF HELICAL TUBE BUNDLES AS USED IN STEAM GENERATORS OF GAS-COOLED REACTORS. P. V. Gilli (Waagner-Biro A. G., Vienna). May 1964. 15p.

Helical tube bundles are being used for steam generators in gas-cooled reactors of the natural-uranium, CO_2-cooled, and the high-temperature helium-cooled type. The steam generators (primary heat exchangers) of the O.E.C.D. High Temperature Reactor Project Dragon that were designed and manufactured by the Waagner-Biro A.G. in co-operation with the Dragon Project are of particular interest since they are compact units of extremely high power-density. Heat transferred per unit tube bundle volume amounts to 12.0 Mw/m^3, per internal casing volume to 3.02 Mw/m^3. Steam rate per unit volume is 23,000 and 5,770 $kg/h \cdot m^3$, respectively. These values compare favorably with existing conventional or nuclear steam generators with gases as heat transfer media. The high density of heat transfer and steam production of the Dragon boilers is due, among other reasons, to the somewhat novel compact tube arrangement. Each one of the six Dragon steam generator units consists of seven concentric cylinders of helical evaporator tubes in a multi-start arrangement with numbers of starts increasing with helix diameter. Hence the angles of inclination as well as the heated lengths of the tubes are equal despite the large diameter differences of the seven helices; thus, flow resistance and mass flow per tube are equal. Little published data are available on the heat transfer characteristics of bundles of plain helically wound tubes in general and no data on the effects of the continuous change between in-line and staggered tube arrangement, which is a characteristic of the design described, in particular. An experimental program dealing with gas-side as well as steam/water-side heat transfer was therefore initiated and is reported upon. (auth)

38278 (A/CONF.28/P/528) EXPERIMENTAL LOOP OF THE REACTOR KS-150. F. Klif (Ceskoslovenska Akademie Ved. Ustav Jaderneho Vyzkumu, Rez), J. Hanzlik, V. Patrovskii, Velechovskii, and J. Zbehlik. May 1964. 12p.

The reactor design and the project of the first Czechoslovak nuclear power plant are being solved in such a way as to permit building-in channels, cooling, circulating and auxiliary facilities of the experimental loop for the examination of new types of fuel elements in an individual circulating circuit. The loop will permit examining large fuel elements (diameter up to 65 cm, length up to 3.7 m) in a high neutron flux and under high thermal loads. The thermal loop output will attain up to 1.75 Mev, coolant consumption up to 23 t/h and pressure gradient in the main circuit up to 20 kg/cm^2. The channel design and loop project, its essential parameters and experimental capacity will be described in the report and the effect of this design on reactor and power plant operation is analyzed. (auth)

38279 (A/CONF.28/P/593) THIN-WALLED STAINLESS STEEL AS FUEL CLADDING MATERIAL IN WATER-COOLED POWER REACTORS. Steinar Aas, Ragnar H. Soevik, Ketil Videm, and Erik Brodahl (Norway. Institutt for Atomenergi, Kjeller). May 1964. 15p.

The relatively high neutron absorption cross section of stainless steel indicates that an appreciably improved economy can be achieved through reduction of the wall thickness. Reducing the wall thickness means increased stresses and the tube will eventually collapse on to the fuel, which will carry the outer pressure. Results from investigations of the mode of collapse as function of tube-diameter, wall thickness, and gap are reported. The fission gas pressure may in certain cases become large enough to deform the canning. Results from experiments in which calculated and observed yield- and bursting-pressures were correlated are given. The general corrosion rate of austenitic stainless steel is considered very satisfactory in water. Pitting corrosion or other forms of non-uniform corrosive attack is more dangerous as pits may very easily penetrate the thin wall. Observations from some experiments into this matter are given. Welding of thin-walled tubes requires careful plug design and welding technique. Examples of plug designs, welding cycles, and equipment are given. The assembly of long thin-walled fuel stringers into clusters can be done by brazing. Equipment and procedures are described. Assembly can be done by using wire spacers, and some experiences with such types are reported. (auth)

38280 (A/CONF.28/P/629) STABILITY ANALYSIS AND DYNAMIC PERFORMANCE OF A CHEMICAL SYSTEM OPERATED FOR THE AUTOMATIC FINE CONTROL OF A NUCLEAR REACTOR. G. C. Ambrosini (Italy. Comitato Nazionale per l'Energia Nucleare. Centro di Studi Nucleari, Casaccia), T. Bozzoni, G. Cipollina, E. Colussi, and R. Garroni. May 1964. 16p.

An automatic fine control system was designed and satisfactorily operated in which the regulating rods and drive are replaced by a boric acid solution circulating in a tube near the reactor core. Analytical studies were performed on a linearized model of the system, using conventional methods of feedback theory; and the validity of the linear model was checked by simulating the whole system on an analog computer. The analytical and analog results were confirmed by operational tests of the system on the AVOGADRO swimming-pool reactor. (D.C.W.)

38281 (A/CONF.28/P/631) REACTOR CONTROL SYSTEMS WITH MOVING DETECTORS AND THEIR PERSPECTIVES. Pavel Kovanic (Ceskoslovenska Akademie Ved. Ustav Jaderneho Vyzkumu, Rez) and Karel Wagner. May 1964. 19p.

The advantages of control systems using servomechanisms with moving detectors are indicated; and the Czechoslovakian development program on such systems is summarized, with emphasis on the transfer functions of the measurement and control systems. The automatic control system developed for the WWR-5 reactor is described, together with the operation. (D.C.W.)

38282 (A/CONF.28/P/677) UN NOUVEAU SYSTEME DE CONTROLE DES REACTEURS NUCLEAIRES. (A New System for the Control of Nuclear Reactors). I. Iftode, C. Tapu, and C. Dobrescu (Academia R. P. R. Institutul de Fizica Atomica, Bucharest). May 1964. 15p.

The paper describes a system of control of the principal operational functions of research reactors (in particular the VVR-S Reactor at Bucharest). The chief functions considered are: start-up from zero power; stabilization and operation at a given power level; transition from one power level to another; operation in accordance with a particular power program; and protection of the reactor when a given power level is exceeded. For start-up, the variation in the signal proportional to the reactor power (8 to 10 decades) is compressed by means of operational amplifiers whose gain is automatically adjusted (feedback resistors) as a function of the input signal (ionization chamber current). The output voltage of the amplifiers is automatically kept between the limits U_{min}–U_{max} so that there is no need for logarithmic amplifiers over a wide range of power variations. During start-up or during large changes in power level the reactor is protected by the period, and during operation at a given power level protection is achieved by exceeding the level. Compared with other systems, the one described has the advantage of employing a small number of relatively simple components, thus simplifying checking and maintenance work. The use of operational amplifiers makes it possible to add other computing elements to the system. (auth)

38283 (A/CONF.28/P/721) DESCRIPTION OF NEUTRON ATTENUATION BY BIOLOGICAL SHIELD WITH THE AID OF MULTIGROUP MODEL TO DIFFUSION APPROXIMATION. V. A. Naumov (Akademiya Nauk Belorusskoi S.S.R., Minsk). May 1964. 19p.

Multigroup diffusion theory methods, used for calculations of physical effects in reactor cores, are extended for calculation of neutron flux attenuation by multilayer biological shields (metal-water shields). The applicability of the method for thermal and biological shields is shown by analysis of predicted and experimental data on the neutron flux distributions in biological shields of the research reactor IRT (Russia) and power reactor APPR (USA). (auth)

38284 (A/CONF.28/P/795) SOLID-STATE NUCLEAR SAFETY SYSTEM. L. Conti and M. Conti (Italy. Comitato Nazionale per l'Energia Nucleare. Centro di Studi Nucleari, Casaccia). May 1964. 13p.

A solid-state-safety system is described. An electrometer amplifier and a shutdown amplifier, using a continuous check method, were developed in the area of alarm situation detectors. The fail-safe logic network which works out the various alarm signals is discussed. The magnet switch power amplifiers, built to supply direct current for energizing the scram, are considered. All alarm signals are under voltage; under alarm conditions, the voltage becomes zero. (M.J.T.)

38285 (A/CONF.28/P/808) FUEL HANDLING EQUIPMENT FOR THE AGESTA D_2O MODERATED PRESSURE VESSEL REACTOR. G. Granelli (Aktiebolaget Atomenergi, Stockholm), G. Fagerlund, S-O Brunzell, and G. Froeman. May 1964. 13p.

Some aspects of the philosophy and the experience of design, manufacture, and tests are given. The fuel handling has to be carried out under gas-tight and radiation-protected conditions, the fuel handling machine and the fuel storage must be provided with an effective cooling system for all conceivable running conditions, the maneuvering system must be fool-proof, and the D_2O condensate in the charge machine has to be collected and prevented from mixing with H_2O. In order to make the design as simple as possible, it was decided to use a joint charge pipe for the four closest element positions. The charge pipe also contains the control rod that is serviced by the charge machine. The fuel elements hang from hooks below the reactor lid and are handled by means of a fork-grab located in the fueling machine. Each operation is started and stopped manually. To make the system fool-proof, interlocks are used and manual overriding is provided on all basic operations. (auth)

38286 (A/CONF.28/P/835) SYSTÈME POUR L'AMENAGE PRÉCIS AUTOMATIQUE DE L'APPAREIL DE MANUTENTION DES ÉLÉMENTS COMBUSTIBLES. (A System

for Accurate Automatic Location of Fuel Element Charging Machinery). Jaroslav Havel and Miroslav Kondr (Skoda Works, Pilsen, Czechoslovakia). May 1964. 11p.

A system is described for automatic positioning and accurate centering of a fuel handling machine designed for changing fuel elements during reactor operation at full load. Motion of the machine is controlled with selsyn motors and television; precision alignment is ensured by a photoelectric arrangement. (D.C.W.)

38287 (IDO-16884) TRANSIENT TEMPERATURE DISTRIBUTIONS IN THE SPERT I D-12/25 FUEL PLATES DURING SHORT-PERIOD POWER EXCURSIONS. J. E. Houghtaling, Alain Sola, and A. H. Spano (Phillips Petroleum Co., Atomic Energy Div., Idaho Falls, Idaho). June 1964. Contract AT(10-1)-205. 49p.

The results of experimental measurements and calculations of the transient fuel-plate temperatures obtained in the short-period power excursion tests of the Spert I plate-type destructive test program are presented. In this program, step-initiated, self-limiting transients, with reactor periods in the range from 1.3 sec to 3.2 msec, were performed on a water-moderated, highly enriched U–Al alloy, plate-type core. In the final 3.2-msec-period test, a large-amplitude pressure burst was suddenly generated several msec after the nuclear excursion had effectively terminated, resulting in large scale destruction of the core. Transient fuel plate surface temperature data were obtained during the tests using small-mass, fast-response, chromel-alumel thermocouples. These data were used as input in computer calculations of the transient temperature distributions in the fuel plates. For the 3.2-msec-period destructive test, the calculational results indicate that the fuel plate meat temperature at the core hot spot reached a maximum value of approximately 1400°C during the excursion, decreasing thereafter to a value of about 1000°C at the time the core was violently destroyed. Based on these calculations approximately one-third of the fuel plate volume in the core had reached the melting point at the time of core destruction. The fuel plate temperatures achieved during the destructive test do not appear to be sufficiently high to make an aluminum–water chemical reaction a reasonable cause of the large, sudden pressure burst. A more likely mechanism, consistent with the analytical results showing that a sizeable volume of the core was in a molten and physically weakened condition at the time of the pressure pulse, involves the self propagating effect of rapid fuel plate fragmentation giving rise to high heat transfer rates to the water with the consequent generation of large steam pressures. (auth)

38288 VIEWPOINTS AND PRINCIPAL CHARACTERISTICS INVOLVED IN THE SELECTION OF REACTOR COOLING AGENTS. Jozsef Halzl. Energia Atomtech., 15: 267-72(June 1962). (In Hungarian)

The requirements governing the selection of coolants are summarized; and the main physical properties of gaseous, liquid, and liquid-metal coolants under consideration are tabulated, assuming a full-load operational period of 60 days. (D.C.W.)

38289 EXTERNAL LOOP COMPONENTS. Charles F. Bonilla (Columbia Univ., New York). p.107-26 of "Reactor Handbook. Second Edition, Revised and Enlarged. Vol. IV. Engineering." New York, Interscience Publishers, 1964.

Pumps, piping, and fittings for light water, heavy water, and liquid metals are discussed. Design and fabrication of tanks and pressure vessels are discussed. (R.E.U.)

38290 MAINTENANCE OF COOLANTS. Lamar P. Bupp (General Electric Co., Richland, Wash.). p.307-45 of "Reactor Handbook. Second Edition, Revised and Enlarged. Vol. IV. Engineering." New York, Interscience Publishers, 1964.

Coolant maintenance problems such as radiolytic decomposition, radioactivity, and corrosive effects are considered in general and for specific reactors. Light- and heavy-water, liquid metals, air, and organic solutions are considered. Coolant maintenance in MTR, ETR, BNL, and ORNL graphite reactors is discussed. A bibliography of 128 references is included. (R.E.U.)

38291 SHIELDING. Harold S. Davis (General Electric Co., Richland, Wash.). p.401-22 of "Reactor Handbook. Second Edition, Revised and Enlarged. Vol. IV. Engineering." New York, Interscience Publishers, 1964.

Engineering aspects of reactor shield design and construction are discussed. Applied shield theory, practical aspects of shield design, and concrete shields are included. (R.E.U.)

38292 REACTOR DEVELOPMENT TEST FACILITIES. L. W. Fromm, Jr. (Argonne National Lab., Ill.). p.539-47 of "Reactor Handbook. Second Edition, Revised and Enlarged. Vol. IV. Engineering." New York, Interscience Publishers, 1964.

Equipment and procedures involved in developing and testing reactor components and materials to assure adequate performance are discussed. Examples of in-pile and out-of-pile tests are given for water and sodium coolants because of their present importance in reactor technology. (R.E.U.)

38293 REACTOR FUEL HANDLING HOOD. Raymond Cagin, Maisons Lafitte, Paul Chemin, Jean Millot, and Pierre Mulot (to Commissariat à l'Énergie Atomique). U. S. Patent 3,143,226. Aug. 4, 1964. Priority date June 22, 1961, France.

A mechanical device is designed for operating the fuel element magazine of a "handling hood" used in the loading and unloading of a reactor. The device removes the plugs from the orifices of the hood by means of a gear-worm-screw arrangement and also rotates the magazine, and only one motor is required. (D.L.C.)

Criticality Studies

Refer also to abstract 38037.

38294 (A/CONF.28/P/25) LATTICE STUDIES AT CHALK RIVER AND THEIR INTERPRETATION. R. E. Green, C. B. Bigham, I. H. Gibson, R. G. Jarvis, M. J. Halsall, F. E. Driggers, and C. H. Miller (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.). May 1964. 15p.

Lattice parameters are studied in natural-uranium-fueled heavy-water-moderated pressure-tube type reactors. The ZED-2, ZEEP, and CANDU Reactors are used in this study and their results are obtained by experimental techniques and analyzed theoretically by computer codes LATREP and LATTICE ANALYSIS. The analytical methods are outlined and correlated with the experiments. (N.W.R.)

38295 (A/CONF.28/P/28) REACTOR SAFETY PRACTICE AND EXPERIENCE IN CANADA. G. C. Laurence, F. C. Boyd, J. H. Jennekens, J. B. Sutherland, and P. E. Hamel (Canada. Atomic Energy Control Board, Ottawa). May 1964. 12p.

Guidelines set up by the Canadian reactor safety control boards are outlined. Regulations applicable to reactor process equipment, containment systems, and protective equipment are indicated. (T.F.H.)

38296 (A/CONF.28/P/75) GRAPHITE REACTOR PHYSICS. Pierre Bacher (France. Commissariat à l'Énergie Atomique, Paris); François Cogne, and Bernard Noc. May 1964. 14p.

The study of graphite–natural uranium power reactor physics, undertaken when the Marcoule piles were built, has continued to keep in step with the development of this type of pile. The critical facility MARIUS has been available for a systematic study of the properties of lattices as a function of their pitch, fuel geometry, and diameter of cooling channels. This study has covered a lattice pitch varying from 19 to 38 cm, uranium rods and tubes of cross sections from 6 to 35 cm^2, and channels with diameters between 70 and 140 mm. The lattice calculation methods could thus be checked and where necessary adapted. The running of the Marcoule piles and the experiments carried out on them during the last few years have supplied information on the overall evolution of the neutronic properties of the fuel as a function of irradiation. More detailed experiments have also been performed in MARIUS with plutonium-containing fuels (irradiated or synthetic fuels), and will be undertaken at the beginning of 1965 at high temperature in the critical facility CESAR, which is being completed at Cadarache. Spent fuel analyses complement these results and help in their interpretation. The thermalization and spectra theories can thus be verified over the whole valid temperature range. The efficiency of control rods as a function of their dimensions, the materials of which they are made, and the lattices surrounding them has been measured in MARIUS, and the results compared with calculation on the one hand and with the measurements carried out in EDF 1 on the other. Studies on the control proper of graphite piles were concerned essentially with the risks of spatial instability and the means of detecting and controlling them, and with flux distortions caused by the control rods. (auth)

38297 (A/CONF.28/P/76) HEAVY WATER REACTOR PHYSICS. Yves Girard, Pierre Lourme, and Roger Naudet (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 17p.

A research program on heavy water reactor physics has been carried out. The decision to build the EL 4 prototype (and so to choose the heavy water gas cooled type) has renewed the interest in this program and at the same time given to it a more specific orientation. A summary of the results gained in this field is presented. Experimental investigations, mostly carried out in the criticality facility Aquilon II, are described. A summary is also given of the theoretical studies. The results allow an improvement of the calculation methods, lead to a better understanding of the neutron balance in lattices, and permit the establishment of a set of formulas to predict not only the clean fuel conditions but also the evolution of the nuclear properties with irradiation. Specific studies on power reactor are quoted. (auth)

38298 (A/CONF.28/P/102) EXPERIMENTAL METHODS IN THERMAL REACTOR PHYSICS. Denis Breton and Pierre Lafore (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 16p.

An outline is presented of the methods used in physics measurements in CEA critical experiments and power reactors. These measurements include general (neutron flux, power density, etc.), kinetics (pulsed neutrons, oscillations), poisoning by solutions, spectral studies, and shielding studies. Some experimental results are given. (D.L.C.)

38299 (A/CONF.28/P/165) THERMAL REACTOR PHYSICS STUDIES ON PLUTONIUM FUELS. J. R. Askew and J. E. Sanders (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Establishment, Winfrith, Dorset, England). May 1964. 15p.

Results of experimental measurements on a range of plutonium-fueled, water- and graphite-moderated, subcritical and critical assemblies are described and compared with calculations using multigroup diffusion and transport theory methods. Accounts are given of the equipment, fuel elements, and experimental techniques. Bucklings of assemblies fueled with thin plutonium–aluminum alloy plates, and with plutonium–uranium alloy bars have been determined by the exponential method. Relative reaction rates of various nuclides have been measured in these assemblies to provide a check on accuracy of spectrum calculations. Experiments on a plutonium-fueled graphite-moderated critical assembly have been carried out to obtain temperature coefficients of reactivity and power distributions. A direct measurement of the neutron energy spectrum in this system has been made by the time-of-flight technique. A new 40-group scheme of calculation based on the Winfrith DSN code is described. A discussion of the basic nuclear data for fuel and moderator used in this scheme is given. The agreement achieved between theoretical prediction and experimentally determined reactivity, temperature coefficients, reaction rates, and neutron energy spectra is discussed, and compared with that found for similar uranium-fueled systems. Conclusions are presented concerning the adequacy of the theoretical methods and nuclear data, and proposed extensions of the theoretical and experimental work to further systems are described. (auth)

38300 (A/CONF.28/P/166) FAST REACTOR PHYSICS, INCLUDING RESULTS FROM U.K. ZERO POWER REACTORS. R. D. Smith (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Establishment, Winfrith, Dorset, England), A. R. Baker, E. P. Hicks, J. E. Mann, J. L. Rowlands, D. C. Smith, and J. Weale. May 1964. 15p.

The nuclear data needed for fast reactor calculations cover a wide energy range, and measurements are not sufficiently comprehensive and accurate to be used as the sole basis for calculation. Thus the calculations for fast reactors commonly use sets of data in a number of energy groups in which the contents have been selected or adjusted as a result of measurements on zero power reactors. The sets used are reviewed and their defects discussed. A new approach using GALAXY and the Data File has been developed, which approaches the ideal of calculations based solely on basic nuclear data. Calculations for fast reactors use a number of well-proved transport and diffusion theory codes, which can be used with up to about 30 groups in one or two dimensions. These calculations give the spectrum above about 50 kev fairly well. Problems arise in extending these calculations to three dimensions and in covering the region from 50 kev to 50 ev, where resonance effects are important. This energy region is of interest in the calculation of sodium and Doppler temperature and power coefficients. The dynamic behavior of the reactor and the control system used depends on the values of these power and temperature coefficients, though it is possible to design an entirely satisfactory control system even with unfavorable power coefficients. A more stringent limitation on possible values of temperature coefficients arises in the study of reactor accidents. The types of accident that need to be

studied are reviewed and their interpretation with the reactivity coefficients considered. These accidents include coolant-flow failure and accidental ramp or step reactivity additions. The reliability of present methods of calculating the dynamic behavior of a reactor is considered in the light of the agreement between calculation and experiment on the D.F.R. These methods are used to predict the behavior of a large power fast reactor, and the importance of the Doppler temperature coefficient of reactivity demonstrated. The Doppler effect also has a profound influence in the case of the hypothetical accident resulting from the melt-down of a fast reactor core and leading to the formation of a super-prompt-critical assembly. It is shown that a relatively small Doppler coefficient will reduce the energy yield in the resulting power excursion by a large factor. In order to fix the design of a power reactor it is necessary to make a choice out of a large number of variable design parameters. To make a systematic choice possible a computer program has been written to enable the effects of variation in a basic design to be assessed rapidly. The capabilities of this program are discussed and some results of the survey are presented. The data and calculation methods used in the design of the P.F.R. are being checked against measurements made in zero-power assemblies. Results from Vera, Zebra, and Quagga are quoted and the choice of assemblies to emphasize particular nuclear data discussed. The experimental results are then compared with the theoretical predictions for critical mass, spectrum, and reaction rates, and the observed discrepancies discussed. The prediction of the Doppler coefficient of a power reactor can be improved by measurements made in a zero power reactor. (auth)

38301 (A/CONF.28/P/169) CALCULATION OF REACTOR POWER AND TEMPERATURE DISTRIBUTION IN THREE SPATIAL DIMENSIONS. A. B. Whiteley (Gt. Brit. Central Electricity Generating Board, London), R. Prescott, J. J. Syrett, J. Walsh, A. N. Buckler, J. G. Tyror, and H. E. Wrigley. May 1964. 14p.

The development is described of a large computer program written for the IBM 7090 computer to calculate steady state reactor power and temperature distributions in three spatial dimensions. The major part of the calculation is the solution of the group diffusion equations for up to five energy groups in a nonlinear form, i.e. with explicit reactivity feedback effects due to material temperatures and to xenon-135 concentration. The diffusion equations are solved by finite-difference methods using a point successive over-relaxation iterative scheme with Chebyshev extrapolation of the sources. The ancillary equations defining temperatures and xenon-135 concentration are solved periodically; the coefficients of the diffusion equations are then re-evaluated and the finite-difference matrices modified accordingly before proceeding with further flux iterations. The reasons for the choice of numerical techniques employed are discussed and programming methods and problems are noted. Two techniques have been developed to increase the scope of the diffusion calculation. These are firstly, a method of representing discrete absorbers (control rods) at any point within a finite difference mesh, and secondly, a method of super-imposing a fine-structure calculation of the source-sink type on the macroscopic flux distribution obtained from the diffusion theory calculation. These techniques (which are described in detail) have been developed in order that detailed studies of complete power reactors can be made without the use of an excessive number of finite difference mesh points when solving the diffusion equation. The main diffusion program together with subsidiary programs to calculate flux fine structure and absorber data have all been written and tested. The diffusion program has shown satisfactory rates of convergence in both two-group and five-group cases and the computation time is considered to be reasonable. Intended future use of the program is discussed and the extension of the basic steady state diffusion program to a time-dependent model for the study of reactor transients is also noted. (auth)

38302 (A/CONF.28/P/172) STUDIES OF RESONANCE ABSORPTION AND THE DOPPLER PHENOMENON FOR FAST AND THERMAL REACTORS. J. Codd, J. E. Beardwood, D. C. Leslie, and H. M. Sumner (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). May 1964. 15p.

Resonance absorption and its temperature dependence in dilute fast reactors are investigated. Two particular problems are discussed with special reference to the Doppler temperature coefficient: the overlapping of resonances of the fissile and fertile constituents of the fuel; and the consequences of using multilevel resonance theory instead of single-level theory. A numerical method for treating the resonance energy region of dilute fast reactors is described. This method allows automatically for resonance overlapping and multilevel theory as well as for core heterogeneity, and enables the detailed neutron energy spectrum between 20 kev and thermal energies to be calculated. Some results from a preliminary test of the method for a homogeneous mixture of uranium-238 and carbon are compared with calculations using a conventional method. Resonance integrals for heterogeneous thermal reactors are calculated. The use of equivalence theorems, which enable results for a homogeneous medium to be applied to a heterogeneous system, is explained. An improved form of the standard equivalence theorem for isolated solid fuel rods is derived. The application of equivalence theorems to treat regular arrays or finite clusters of fuel rods is discussed, introducing the concept of "effective surface." A method of calculating this parameter for liquid-filled arrays or clusters is outlined. Calculated values of the resonance integral and its temperature dependence are then compared with experimental data on UO_2 rods and clusters, and also with results obtained by the Monte Carlo method. An investigation is made of the resonance integral for fissile isotopes when mixed with uranium-238, with particular attention to the effect of resonance overlapping. Numerical results are compared with measurements of the relative reaction rates of fissile samples in uranium and copper bars, which were irradiated in a uranium-fueled graphite lattice. (auth)

38303 (A/CONF.28/P/361) INVESTIGATION ON SYSTEM WITH ZIRCONIUM HYDRIDE MODERATOR. N. N. Ponomarev-Stepnoi, O. N. Smirnov, and R. V. Kuleva (U.S.S.R.). May 1964. 16p.

The clusters studied are a system of alternating layers of fuel and moderator. The flat-type fuel elements consist of teflon-4 mixed with 90%-enriched uranous-uranic oxide. The ZrH_n moderator blocks are shaped and sized to ensure moderator arrangement in layers of different thickness. Critical experiments and measurements on critical clusters were performed. Results with unreflected ZrH_n + ^{235}U systems were generalized and presented in the form of a B–C diagram (B is material buckling, C, concentration). The effect of fissionable-material self-shielding on the reactor critical parameters was studied. Efficiency

of various reflectors (Be, BeO, ZrH_n) was analyzed. The effect on the critical parameters of various absorbers uniformly distributed in the core volume was studied. Neutron spectral characteristics in the tested clusters were measured. Measurement results for determination of the neutron spatial distribution in the reactor volume and core cell are cited. The proper method for carrying out neutron physical calculations of these quasi-homogeneous reactor systems was selected. (M.J.T.)

38304 (A/CONF.28/P/362) NEUTRON PHYSICAL CHARACTERISTICS OF U + Be AND U + BeO SYSTEMS. I. I. Bondarenko, V. P. Garin, R. K. Goncharov, et al. (U.S.S.R.). May 1964. 22p.

For near-homogeneous systems with highly enriched uranium, critical parameters, neutron spectra, reflector effects, dynamics, and control-component effectiveness at various positions were investigated experimentally for varying fissionable material concentrations and geometries. Multi-group methods of calculation for these assemblies were corrected on the basis of the experimental data. For heterogeneous lattices using natural and slightly enriched uranium, experiments included the investigation of the critical lattice parameters (K_∞ and its cofactors) and the space-energy distribution of the neutrons, using a mechanical selector. Contribution to K_∞ from (n,2n) and (γ,n) reactions on beryllium is assessed. For pure moderators, experimental results for neutron ages, square diffusion lengths, and diffusion constants are given. Calculation results showing the importance of the (n,2n) process in neutron multiplication are presented. (M.J.T.)

38305 (A/CONF.28/P/374) O PREDELNOI PLOTNOSTI NEITRONOV V REAKTORE S OGRANICHENNYM RAZOGREVOM TEPLONOSITELYA. (Maximum Density of Neutrons in a Reactor with Limited Heat-up of the Coolant). Ya. V. Shevelev (U.S.S.R.). May 1964. 18p.

Pulse-type homogeneous and heterogeneous reactors with one-way flow of the coolant have practically the same limit to which the neutron density can be increased. The maximum density is roughly equal to the energy which can be imparted to one volume unit of the coolant during one heating cycle divided by the energy liberated during one fission. If the design of the reactor is such that the coolant must be kept from plasma state, $n_{max.} \approx 10^{14}$ cm^{-3}. The limit can be extended by making use of the oncoming motion of the coolant streams. (auth)

38306 (A/CONF.28/P/499) MICROSCOPIC NEUTRON FLUX DISTRIBUTIONS IN UNIT CELLS OF CRITICAL ASSEMBLIES OF THE NPY PROJECT. L. Adamski (Polish Academy of Sciences. Inst. of Nuclear Research, Swierk), J. Arkuszewski, R. Bednarz, et al. May 1964. 15p.

According to the NPY Cooperative Program a series of neutron flux distribution measurements and calculations were made for each of three critical assemblies in Norway, Poland, and Yugoslavia. The measurements made on 3%-enriched uranium rods in the D_2O-moderated Norwegian "NORA" reactor, on 20%-enriched 3-concentric tubular fuel elements in the graphite-water moderated Polish reactor ANNA, and on 2%-enriched tubular-type fuel elements in the D_2O-moderated Yugoslavian RB reactor are discussed. Experimental results are analyzed using 3 independent reactor cell calculation methods, "K.7 – Thermos" code developed at Kjeller, and analytical thermalization methods developed in Poland and Yugoslavia. (auth)

38307 (A/CONF.28/P/511) INELASTIC SCATTERING OF HIGH-ENERGY NEUTRONS IN FAST REACTORS. G. Szwarcbaum, M. Sieger, and S. Yiftah (Israel. Atomic Energy Commission. Soreq Research Establishment, Rehovoth). May 1964. 20p.

For neutrons above 1 or 2 Mev, inelastic scattering is described to a good approximation by an evaporation formula. It is necessary to find fitting values for the nuclear temperature at various energies and for a wide range of nuclides. The formulas for the nuclear temperature, θ, are obtained as derivatives of the formulas for the average level spacing, D. Usually, first parameters appearing in the formula for D are fitted to the experimental data, and then the formula for the nuclear temperature is derived. It is advantageous first to derive the formula for θ, in which only one parameter is involved. The fit with experiment is done for parameters in the formulas resulting from the three most common formulas for D—those of Weisskopf, Bethe and Lang-Le-Couteur. This is done by minimizing the χ^2 function. Comparison of the improved formulas shows that all describe equally well the experimental data and yield lower values for the nuclear temperature. On the basis of the improved Weisskopf formula, new multigroup inelastic cross sections are derived and used in the calculation of several fast assemblies. The calculated critical masses are generally in slightly better agreement with experiment than previous calculations. (auth)

38308 (A/CONF.28/P/596) THE NPY-PROJECT—A CO-OPERATIVE RESEARCH PROGRAMME IN REACTOR PHYSICS BETWEEN NORWAY-POLAND-YUGOSLAVIA AND IAEA. V. O. Eriksen (Norway. Institutt for Atomenergi, Kjeller), N. Raisić, R. Zelazny, and B. Semenov. May 1964. 7p.

It is expected that may advantages could result from a co-ordination of research programs in reactor physics of different national institutions so as to permit a concerted attack on problems of common interest. The NPY-Project between Norway-Poland-Yugoslavia with IAEA as a catalyser is an attempt to explore the merits of a co-operative effort in reactor physics. The main objectives of the NPY-Project are that the Signatories should co-operate in the development of experimental techniques in reactor physics and to test and check their applicability, validity and accuracy and they should further develop theoretical models and methods used in lattice calculations, in interpretation of experimental data and test the extent of their validity. An outline of the joint tasks undertaken is given. (auth)

38309 (A/CONF.28/P/632) SOME ITERATIVE METHODS FOR CONSTRUCTION OF SOLUTIONS OF NEUTRON TRANSPORT EQUATIONS. Ivo Marek (Karlova Universita, Prague). May 1964. 12p.

The neutron transport equations can be written in the time independent case in the form $Lx = Bx + \lambda Cx + s$, where the operators L, B, C and the vectors x, s have the following meaning: the operator L denotes the diffusion and absorption, B the scattering, and C the fission; the vector x denotes the density of neutrons or the neutron-flux; and s denotes the exterior sources. Let the equation describe the neutron transport in a given bounded domain r. The form of the operators L, B, C depends on the approximation in which the neutron transport is concerned. It can be proved that the equation $Lx = Bx + \lambda Cx$ has a solution x_0 which is positive in r. This solution corresponds to the positive characteristic value λ_0, for which the inequality $|\lambda| > \lambda_0$ holds for every different characteristic value λ of the latter equation. Moreover this equation has no non-negative solution in r other than Cx_0, where C

is a positive constant. This result is a consequence of properties of the operators $(L - B)^{-1}C$ and $C(L - B)^{-1}$. It can be proved that the value $\mu_0 = \lambda_0^{-1}$ is the dominant eigenvalue of the operator T, where T denotes one of the operators $(L - B)^{-1}C$, $C(L - B)^{-1}$. To construct the eigenelements of the latter equation and the solutions of the former equation, iterative methods are suitable. A general iterative schedule is presented and its convergence is proven. (auth)

38310 (A/CONF.28/P/640) NEW ASPECTS IN THE APPLICATION OF COLLISION PROBABILITIES IN REACTOR THEORY. Hans Maerkl (Siemens-Schuckertwerke A. G., Erlangen, Germany). May 1964. 20p.

Computational methods involving the application of collision probabilities have been developed at the Siemens Reactor Department with the objective of basing the lattice calculational program on a common collision probability concept. These methods are reviewed and recent developments are described. In particular, problems associated with neutron spectra and physical lattice properties of heterogeneous media are dealt with. (auth)

38311 (A/CONF.28/P/645) THEORETICAL AND EXPERIMENTAL INVESTIGATIONS OF SLIGHTLY ENRICHED ZIRCONIUM-HYDRIDE MODERATED LATTICES. K. Einfeld, G. Memmert, W. Ullrich, and S. Wiesner (Internationale Atomreaktorbau G.m.b.H., Bensberg, Germany). May 1964. 20p.

In connection with the development of a heterogeneous zirconium-hydride moderated reactor, several critical and sub-critical measurements on lattices have been performed. These tests were performed in a fixed aluminum lattice by varying the arrangement of rods containing UO_2 or zirconium-hydride with equivalent diameters. The time-dependent neutron flux behavior after a neutron pulse was measured. The higher harmonic effects were eliminated through a numerical evaluation method which permitted the determination of the characteristic decay constants, as eigenvalues can also be directly calculated for a given system through theoretical methods, developed and employed for this purpose. The reliability of these methods can be illustrated with an example of a UO_2–H_2O experimental core with a large reflector. Measurements were performed on various zirconium-hydride lattices up to 450°C, in order to determine the temperature dependence of the reactivity. This dependence is of special interest in the case of zirconium-hydride moderation. In this connection several theoretical expressions for the scattering kernel and for the heterogeneous spectrum methods were investigated in order to theoretically describe the experimental results as well as possible. The critical experiments were performed on a split-table assembly of the Argonne "ZPR" type and were limited a maximum temperature of 200°C. The results of the sub-critical measurements were in essence verified by the critical assembly. In addition measurements with a pile-oscillator, threshold detectors and resonance detectors were made to obtain a very detailed determination of the cell-parameters. These measurements will, in turn, make possible the determination of the temperature dependence of heterogeneous zirconium-hydride lattices. (auth)

38312 (A/CONF.28/P/648) DETERMINATION OF l_{eff} AND β_{eff} IN A CRITICAL REACTOR BY THE PULSED NEUTRON TECHNIQUE. C. Stassis and C. Mitsonias (Greece. Atomic Energy Commission, Athens). May 1964. 9p.

The values of l_{eff} and β_{eff} for a critical reactor were determined simultaneously by the pulsed neutron technique. The method is based on the analysis of the rise and decay of the thermal neutron density produced by injection of a fast-neutron pulse in the reactor. The measuring equipment consists of a 14-Mev pulse neutron generator, a 512 channel multiscaler, and an automatic device to preset the number of pulses. The method was used to determine the values of l_{eff} and β_{eff} for the "Democritos" reactor. (auth)

38313 (A/CONF.28/P/649) POWER LEVEL TEMPERATURE COEFFICIENT BY ZERO POWER MEASUREMENTS. N. G. Chrysochoides (Greece. Atomic Energy Commission. "Democritus" Nuclear Research Center, Athens). May 1964. 16p.

The reactivity effects of temperature changes in a research or power reactor under various operating conditions is usually determined by experimental measurements. This generally requires a series of experiments in which each type of operating mode is explored. A simple experimental method is described in which zero-power experiments permit evaluation of temperature coefficients applying to any mode of power range operation. The method was used for measurements in a pool reactor but it could be applied to other types of reactors as well where provisions are made for circulating the coolant. Basically the experiment involves the measurement of the single cell temperature coefficient $\alpha_i(r,T)$ for the various locations in the core and reflector, corresponding to a uniform temperature T. Measurements of $\alpha_i(r,T)$ for each cell are obtained by separately heating this particular cell, while the remaining cells are held at a constant temperature by operation of the coolant circulating system. From these data the temperature effects for the following conditions can then be evaluated. (auth)

38314 (A/CONF.28/P/650) LIGHT-WATER-ENRICHED URANIUM LATTICE EXPERIMENTS. F. Szabó (Magyar Tudományos Akadémia Központi Fizikai Kutató Intézete, Budapest). May 1964. 18p.

Light water-moderated 10%-enriched uranium-fueled lattices were investigated with different $H/^{235}U$ ratios. One of the aims of these experiments was to test the results of calculation methods used. For this purpose the measurements were carried out in a wide interval of the $H/^{235}U$ ratio in order to get significant effects. Fuel elements of the VVR-S-type research reactor were used and in most cases triangular lattice patterns applied. Critical mass values were determined over the range 190 to 775 of the $H/^{235}U$ ratio. This range involves nearly equal lengths of under- and over-moderated regions. Temperature dependence of reactivity was determined in the interval 10 to 40°C, in over-moderated, under-moderated, and in a nearly optimum lattice. Temperatures of fuel and moderator were the same. In this temperature interval both positive and negative values of temperature coefficients were found in all the lattices. Spatial dependence of the reactivity effect of vertical, cylindrical voids—the lengths of which were identical with that of the fuel elements—was determined in four cores with different lattice pitches. The values of the void-to-cell-volume ratios were kept nearly the same. Positive void effect was reached in a strongly overmoderated lattice. Thermal neutron distributions were determined in lattices containing central water traps of different diameters. These measurements were carried out both in a strongly under-moderated and in a nearly optimum lattice. The value of β_{eff}/l was measured using both the Feynmann and the Rossi method in a nearly optimum lattice. The two methods yielded nearly the same results. The value of β_{eff}/l was determined in an over- and an under-moderated lattice by the Rossi method only, which proved

to be faster and more accurate. The results of a simple calculation method were compared with the experimental data. Rather good agreement was found for the two-group model when taking into account fission under slowing down and the intracell dependence of the thermal spectrum in the calculation of the thermal utilization factor. (auth)

38315 (A/CONF.28/P/667) REACTOR PHYSICS STUDIES OF NATURAL URANIUM-LIGHT WATER MODERATED LATTICES. W. Rothenstein (Israel. Atomic Energy Commission, Tel-Aviv), G. Ben-David, J. Helholtz, Y. Segal, and D. Tabak. May 1964. 18p.

Experiments were performed using an exponential assembly constructed adjacent to the thermal column of the Israel Research Reactor, which acted as a source of thermal neutrons. The hollow natural uranium fuel slugs (14 mm internal and 28 mm external diameter) were placed at the center of aluminium tubes using aluminium spacers and leaving an air gap of 6 mm width between the fuel and the moderator. The axial and radial flux distributions were measured experimentally by means of dysprosium foils and were least squares fitted to the appropriate theoretical flux shapes to obtain the material bucklings. The lattices contain a considerable volume fraction of aluminium structural material and cladding. After applying appropriate corrections to allow for the effect of the aluminium, the buckling was found to reach a maximum of -2×10^{-4} cm^{-2} at a water to metal volume ratio of about 1.6. The thermal flux distribution in the above lattices was calculated on the basis of monoenergetic transport theory. The boundary conditions previously applied in the spherical harmonics method to connect the moments of the angular flux at the two faces of the air gap were found to be non-unique and were replaced by a simpler set of conditions which made evaluation of higher P_L approximations possible. The calculations of the ratio of the flux at the two faces of the gap were found to be in substantial agreement with experimental measurements. The predicted flux shape in the moderator was found to be flatter than the measured distribution. The discrepancies may be largely attributed to the neglect of thermalization effects in the calculations. In the epithermal region, the Monte Carlo method was used to investigate the effects of void channels on the resonance capture. The Monte Carlo calculations covered energy ranges in which the main resonances of ^{238}U are situated. The resonance escape probability in a lattice with air gaps was found to be somewhat larger than that in the corresponding lattice of equal volume without gaps. This effect is due to the difference in the Dancoff correction in the two cases, which was determined separately and used in the semiempirical formulas of the effective resonance integral for the lattices. The Monte Carlo method was also used to check previous theoretical estimates of the contribution of the ^{238}U p-wave resonances to the effective resonance integral. Theory shows that the contribution, which is independent of temperature, should approach the corresponding value at infinite dilution. While the Monte Carlo estimates confirm this trend, they also showed that the capture is affected to some extent by the close proximity of some p- and s-wave resonances, or p-wave resonances belonging to different values of the total angular momentum of the compound nucleus. (auth)

38316 (A/CONF.28/P/669) EXPERIMENTAL AND THEORETICAL STUDIES OF URANIUM OXIDE LATTICES MODERATED BY MIXTURES OF LIGHT AND HEAVY WATER. E. Andersen, D. Babala, K. Bryhn-Ingebrigtsen, et al. (Norway. Institutt for Atomenergi, Kjeller). May 1964. 15p.

Reactor physics measurements on UO_2 lattices moderated by mixtures of light and heavy water have been performed in the NORA zero power reactor. The fuel used for these experiments has been UO_2 enriched to 3% U^{235} clad in stainless steel. A series of measurements on different H_2O/D_2O ratios and different moderator-to-fuel volume ratios has been completed. Macroscopic and microscopic neutron flux distributions have been measured using different types of foil materials resulting in sets of B_m^2 values and cell parameters for thermal and resonance neutrons. The ratio of epi-cadmium to sub-cadmium capture in U^{238} (ρ^{28}), the ratio of epi-cadmium to sub-cadmium fission in U^{235} (δ^{25}), and initial conversion ratios have been measured. The ratio of Lu-foil activity to Cu-foil activity has been measured in different positions inside the fuel and in the moderator and was compared to calculated values of the same activation ratio and used as a spectral index for the lattices studied. Supplementary to experiments on clean critical cores some measurements on two-region cores have been performed to make it possible to extend the range of measured buckling values considerably. Analysis of the experimental results using multigroup methods both for the fast and thermal neutron region is presented. The neutron energy spectrum in the fast region is calculated by a code BIGG. Resonance absorption and fission are given a correct distribution in energy and are governed by input resonance integrals. BIGG is well adapted to handle slowing down in mixtures of light and heavy water. The thermal part of the neutron spectrum is calculated by the K-7 THERMOS code. (D.L.C.)

38317 (A/CONF.28/P/675) DETERMINATION OF THERMAL NEUTRON SPECTRUM DEFORMATIONS IN HETEROGENEOUS MEDIA BY FREQUENCY RESPONSE METHOD. I. Purica, N. Seferian, and E. Răcătăianu (Academia R. P. R. Institutul de Fizică Atomică, Bucharest). May 1964. 19p.

The possibilities offered by the frequency characteristic method for determining the deformation of the thermal neutron spectrum in a multiplying lattice are analyzed. Use is made of the P_1L_2 approximation. The theoretical results are compared with experiments carried out on an enriched uranium-graphite subcritical assembly. Separation of the effect of absorption in the uranium on deformation of the neutron spectrum is achieved by substituting suitable absorbing and diffusing substances for uranium. (auth)

38318 (A/CONF.28/P/685) SPATIAL KINETICS OF THERMAL REACTORS. O. Norinder (Aktiebolaget Atomenergi, Stockholm). May 1964. 12p.

The theory of reactor spatial kinetics is studied in an attempt to make the theory more clear and simplify its interpretation. Studies that elucidate the kinetic properties of the Marviken reactor are given particular attention. To be significant for this reactor the theory must be valid for macroscopically heterogeneous cores. The actual description of the reactor flux and other variables is mostly founded on the one-group time-dependent neutron diffusion equation. By expansion in the flux-mode system one obtains a graphical description of the time behavior. The significant part of the transient is represented by the fundamental mode and the three higher modes. From the velocity characteristics of the transients one might group them as prompt jump, fuel heat transport and delayed neutron, external heat circuit, xenon, and depletion transients. In kinetic investigations of reactors one generally uses several stability concepts. For a reactor the complete system always must be stable. Spatial stability conveniently is de-

fined as stability without a control system or with a control system actuated by one real variable. Xenon spatial stability may be investigated using flux eigenfunctions. Computed tables of such functions are described. A new theory of void distribution spatial stability is given. The theory makes possible numerical estimates of the stability conditions. In all cases calculations including unstable situations the flux part of the least stable eigenvector had only a small content of non-fundamental mode flux. In all unstable cases computed only this eigenvector had a positive real part eigenvalue. This fact indicates that in many investigations a space-time separated treatment of the flux is possible and that spatial instability in combination with fundamental mode stability is unlikely. For calculation of transients it is mostly necessary to separate the space and time dependence. It is mostly possible to retain the significant characteristics of transients important to the reactor design when a space-time-separated description is used. A short description is given of a code for calculating spatial transients. The possibilities of estimating spatial transient behavior from static flux calculations are investigated. The demands for calculations or reactor spatial transients are discussed. (auth)

38319 (A/CONF.28/P/686) THE EVOLUTION OF FISSION RATE DURING AND AFTER SHUTDOWN OF A NUCLEAR REACTOR. P. Schmid and W. Zuenti (Switzerland. Eidgenossisches Institut fur Reaktorforschung, Würenlingen). May 1964. 15p.

The evolution of the fission rate during and shortly after fast shutdown of a nuclear reactor may contribute essentially to the total heat released to the fuel and is, therefore, subject to estimates both by the design engineers and by safeguard officers. Furthermore the shape of the function representing neutron flux at any location versus the time elapsed after sudden insertion of control absorbers contains essential and reliable information about reactivity in the particular shutdown state. The latter fact was explored, e.g., by recently developed reactivity measurement techniques called modified rod drop method. Upper and lower bounds are found for the fission rate during the finite travel time of the shut-off device. From this an equivalent reactivity step is defined such that the asymptotic evolution of fission rate is matched. For the fission rate after the shut-off device has reached its final position, an expansion into a series of characteristic functions of time is derived, the respective coefficients being given by the powers of the reciprocal reactivity in dollar units. This expansion converges well for final reactivities below −1 s and proves very useful, not only for quick estimates of the fission rate, but also for optimum analysis of modified rod drop experiments. An approximation for the total fission energy released after the initiation of a fast shutdown is presented for sub prompt critical excursions with initial periods not shorter than the (properly defined) travel time of the shut-off device, the latter being driven in with constant acceleration. (auth)

38320 (A/CONF.28/P/690) THE HETEROGENEOUS METHOD AND ITS APPLICATION. T. Auerbach, G. Burnand, and H. Soodak (Switzerland. Eidgenössisches Institut für Reaktorforschung, Wurenlingen). May 1964. 16p.

Heterogeneous methods for lattice calculations are designed for use in cases where the lattice exhibits irregularities of a type that cannot be handled by the usual homogeneous methods. Such irregularities arise when control rods are inserted between fuel elements, in substitution experiments performed in exponential assemblies, or even in complete lattices containing zones of different fuel spacing as in the case of the Lucens reactor. The usual two-group or age diffusion theory, in which fuel elements are represented by line sources and sinks, works reasonably well in lattices whose rods are thin compared to their spacing. The cluster elements proposed for D_2O-moderated power reactors do not fall into this category, however, and introduce the additional complication of axial and radial streaming. The heterogeneous method was extended by incorporating the following features: three energy groups covering the fast region, the resonance region, and the thermal region; the flux at the fuel surface is expanded into a constant "monopole" term plus a dipole term to describe the absorption characteristic of the element and the scattering properties of the fuel as well as radial streaming, respectively; boundary conditions at the fuel surfaces are specified in terms of the linear extrapolation lengths into the fuel; the effects of axial buckling are incorporated into the theory in order to account for axial streaming; and the finite rod radius. (auth)

38321 (A/CONF.28/P/691) NATURAL AND SLIGHTLY ENRICHED URANIUM LATTICE STUDIES OF VOIDED METAL ROD CLUSTERS IN D_2O. H. R. Lutz (Switzerland. Eidgenossisches Institut fur Reaktorforschung, Wurenlingen), R. W. Meier, and J. P. Schneeberger. May 1964. 20p.

A series of lattices consisting of voided rod cluster elements was investigated in the subcritical facility MINOR. This experimental program has formed the basis to check calculation methods for heavy water-moderated and gas-cooled pressure-tube reactors. A detailed analysis was undertaken for an element consisting of 7 uranium metal rods enriched to 0.960%. This rod cluster is supported by a graphite structure, which is surrounded by a pressure tube. An annular air gap separates the pressure from the calandria tube. This cluster presents a physical mockup of the fuel element to be used in the first charge of the Swiss experimental power station presently under construction at Lucens. In order to obtain calculation methods that are of a more general usefulness and have a wider field of application, the experiments specific to the Lucens reactor were extended by varying a number of parameters of the lattice arrangements; the most important change consisted in a replacement of the enriched rods by natural uranium rods, leaving all structural material the same. The void content per cell was decreased by removing the calandria tube and increased by removing the graphite fillers. Some measurements with 4-rod clusters were performed. For all lattices, several moderator-to-fuel volume ratios were investigated. For some or all of the lattices the following parameters were determined: the material buckling; flux disadvantage factors; the epithermal component; Cd-ratio of ^{238}U; and axial flux peaking due to Al spacer pieces. Theoretical interpretations of the experiments have been made on the basis of the two group four factor model. (auth)

38322 (A/CONF.28/P/706) ONE-VELOCITY NEUTRON DIFFUSION CALCULATIONS BASED ON A TWO-GROUP REACTOR MODEL. S. Bingulac, L. Radanovic, B. Lazarevic, and M. Matausek (Institut za Nuklearne Nauke "Boris Kidric," Belgrade). May 1964. 20p.

In evaluating critical dimensions and flux distributions in multiregion nuclear reactors it is advantageous to have a method that retains computational simplicity of one-group treatment and yet approaches the accuracy attainable with a two-group model. Such analytically simple but sufficiently accurate representations of the flux equations are particularly important in dynamic studies when it is necessary to obtain simultaneously the solution of

the flux equation and its adjoint on an analog computer. A procedure is described by which the flux distribution can be represented with an expression of the form: $F^i(r) = F^i_1(r) + Z^i_1 F^i_1(R_i) \exp[-V^i_1(R_i - r)] + Z^i_{1-1} F^i_1(R_{i-1}) \exp[V^i_{1-1}(R_{i-1} - r)]$ where $F^i_1(r)$ is the solution of the one-group diffusion equation in the i-th region of the reactor, defined by the interval: $R_{i-1} \leq r < R_i$, while Z^i_1, Z^i_{1-1}, V^i_1, and V^i_{1-1} are constants. At each interface between two regions, the function $F^i_1(r)$ must satisfy a boundary condition defined by: $\lim_{r \to R_i} [dF^i_1(r)/dr]\,[1/F^i_1(r)] = U^i_1$. In deriving this expression a one dimensional two-group reactor model, adapted for solution on an analog computer, is used. The two-group diffusion equations are transformed into Riccati equations with associated initial and boundary conditions. Using the properties exhibited by the solution of Riccati equations, the multiregion reactor is reduced to only two regions, involving a simple set of equations which determine the critical dimensions and the coefficients: Z^i_1, Z^i_{1-1}, V^i_1, V^i_{1-1}, U^i_1 for all regions. The normalized set of these equations can be solved once for all, whereby a family of curves is obtained, from which critical dimensions and coefficients can easily be determined for various reactor parameters. This procedure is applicable to both spherical and cylindrical geometry and to any arrangement of active zones and reflectors. The practical application and accuracy of this procedure is discussed in specific examples. (auth)

38323 (A/CONF.28/P/707) AN ANALYSIS OF CRITICAL EXPERIMENTS USING THE HETEROGENEOUS REACTOR THEORY. Nenad Raišić and Savo Jovanović (Institut za Nuklearne Nauk "Boris Kidric," Belgrade). May 1964. 14p.

The heterogeneous reactor theory is used for the analysis of critical experiments performed on one and multizone reactor cores. The main reason for this use was to overcome the difficulties which arise in the interpretation of critical experiments when relatively a small number of fuel elements is present and classical flux mapping techniques do not give satisfactory results. The heterogeneous reactor theory in the two-group or continuous slowing down model offers the possibility of determining two main parameters of fuel elements: η, the number of neutrons emitted per neutron absorbed in the fuel, and γ, the number of neutrons absorbed per unit neutron flux on the fuel surface. For this purpose the number of fuel elements and core height in critical conditions have to be experimentally determined. From the results of two experiments with a different number of fuel elements independent quantities η and γ can be determined. In two-zone experiments with known fuel parameters in the reference zone and unknown in the test zone, two successive substitutions allow the determination of unknown fuel parameters. This can be extended to the three-group model which makes possible independent determination of resonance absorption parameters of the fuel. In this case it is assumed that resonance absorption takes place on a single energy line between the first and second neutron energy group. For experimental determination of the resonance parameter it is necessary to undertake three independent critical experiments with a different number of fuel elements, or, in a two-zone system, to proceed with three successive substitutions. A series of one- and two-zone experiments performed on the RB zero power reactor using 2% enriched and natural uranium in different lattice configurations were analyzed by the described method. The obtained results were tested for consistency and reproducibility and compared with the results of the standard interpretation of critical experiments based on homogenization principles. The advantages of the heterogeneous method are evident especially in two-zone substitution experiments. With a sufficient number of fuel elements both methods give equivalent results. In conclusion, advantages and disadvantages of the heterogeneous interpretation of critical experiments are discussed. (auth)

38324 (A/CONF.28/P/713) ON NONLINEAR REACTOR KINETICS. Eino Tunkelo (Finland. Teknillinen Korkeakoulu, Otaniemy). May 1964. 16p.

The nonlinear features of reactor kinetics, including the effect of the prompt negative temperature coefficient of reactivity, were studied experimentally and theoretically. Transients produced by an instantaneous addition of reactivity and the steady-state response of the reactor to sinusoidal variation of reactivity were considered. The experiments were performed with a TRIGA Mark II reactor. The asymmetry of the produced pulse and its succeeding "tail" were studied in the transient experiments. The experimental determination of the pulse was performed by using a boron-coated ionization chamber in connection with a recording oscillograph, by recording the intensity of the Cherenkov radiation in the core with a photomultiplier fitted to an appropriate optical system, and by using a multichannel time analyzer to record the intensity of neutron capture gamma rays from the 8.2-ev resonance of samarium. The subsequently developed theory shows that the measured properties can be described satisfactorily by the properties of the delayed neutron groups and the transfer of heat from the fuel to the water moderator. The response of the reactor to a sinusoidal variation of reactivity was studied in terms of the fundamental and some lower order harmonics as well as subharmonic components. The analysis of the response was performed on the basis of physical concepts as well. The nonlinear transfer functions of the reactor for reactivity variations of larger amplitudes were derived; their relation to the transient properties is discussed. Finally, the stability of the reactor under normal operating conditions was studied and found to be satisfactory. (auth)

38325 (A/CONF.28/P/742) ON TWO SCHEMES FOR NUCLEAR REACTOR CALCULATIONS. R. Ortiz, G. Velarde, R. Caro, J. L. de Francisco, and A. Brd (Spain. Junta de Energia Nuclear, Madrid). May 1964. 20p.

Programs coded at JEN for the UNIVAC USS-90 computer are described. ISLERO solves either the P_1 or B_1 approximation to the one-dimensional, multigroup slowing down Boltzmann equation in an infinite homogeneous slab. PROMETEO I and II solve the Wigner-Wilkins and the Wilkins differential equations, respectively. EDIPO I and II solve the one dimensional, several-group diffusion equations. The total theoretical scheme was applied to the substitution experiments carried out in Aquilon II (Saclay) and to the exponential experiments carried out at JEN, as a part of the DON Project Program for natural uranium carbide-heavy water-organic reactor systems. In all calculations the resonance self-shielding factor was left free as an adjustable parameter. Four-groups diffusion theory was used throughout. (auth)

38326 (A/CONF.28/P/743) EXPERIMENTAL STUDIES OF URANIUM CARBIDE–HEAVY WATER LATTICES. E. Rodriguez Mayquez, J. L. De Francisco, and F. J. Olarte (Spain. Junta de Energia Nuclear, Madrid). May 1964. 18p.

Natural uranium carbide, heavy water-moderated,

organic-cooled lattices were studied in an experimental device made up of an aluminum vessel of about 2-m diameter and 2-m height with a leak-proof cover. The flux distribution measurements can be made at different pitches at the hexagonal lattice. A graphite thermal column with five 10-C Sb–Be neutron sources provides an adequate neutron intensity. The measurements were carried out at 8.5, 9.5, and 10.5 inches. The UC fuel elements used are similar to those of a possible organic-cooled power reactor. The results were compared with measurement carried out with UO_2 fuel element. Another series of measurements, using a progressive substitution technique, were made in the critical facility AQUILON II at Saclay. (auth)

38327 (A/CONF.28/P/826) THE THERMAL FLUX DISTRIBUTION IN THE MODERATOR REGION OF A RECTANGULAR LATTICE OF CYLINDRICAL FUEL ELEMENTS. N. Margalith and Y. Yievin (Hebrew Univ., Jerusalem). May 1964. 15p.

The first transport correction (corresponding to the P_3 approximation) to the asymptotic flux distribution in a rectangular lattice of cylindrical fuel elements with a constant source is derived. The resultant flux distribution is shown to be in satisfactory agreement with measurements on a natural uranium-heavy water lattice. (D.C.W.)

38328 (A/CONF.28/P/846) SUBCRITICALITY MEASUREMENTS BY PULSED METHOD AND CRITICAL EXPERIMENTS ON LIGHT WATER SYSTEM. K. Sumita (Japan Atomic Energy Research Inst., Tokyo), Y. Kaneko, S. Ogura, et al. May 1964. 15p.

Results of pulsed experiments on graphite- and light water-moderated systems, and of the critical experiments on H_2O-UO_2 systems are given. The experimental methods for reactivity measurement in a highly subcritical system, which are based on the measurement of persisting mode and based on that of prompt mode, have theoretical and experimental difficulties. Those are stressed in a reflected system. The purpose of the subcriticality study is to establish another concept to avoid the problems, and to describe rigorously, neutron multiplication in a reflected subcritical system. The concept is that the prompt-neutron decay constant of fundamental mode α_0 should be used directly as a measure of neutron multiplication. In order to prove this characteristic of α_0, a series of pulsed neutron experiments was made at various subcritical states in a reflected graphite-moderated enriched-fuel system (SHE) and a light water-moderated natural UO_2 system. The multigroup subcritical kinetics of the reflected reactor were extended, and the direct comparison between the experimental results from pulsed neutron experiment and the calculated values from multigroup treatment about the systems were made to investigate this concept. The difference between measured and calculated values of α_0 was fairly small. Flux distributions for fully reflected and partly immersed cylindrical, rectangular, and annular cores, and thermal spectrum were measured with various activation detectors such as Dy, Cu, Lu, Au, Mn, and In. Measurements of reactivity include those of critical mass, of temperature coefficient, and of spatially dependent reactivity effects of void, fuel, and absorption materials. Results of these experiments were analyzed primarily with a few-group diffusion model and agreement between experiments and calculations was fairly good. (auth)

38329 (A/CONF.28/P/847) THEORETICAL KINETIC STUDIES OF BOILING WATER REACTORS AND MULTIREGION REACTORS. Tsutom Kanai (Hitachi, Ltd. Central Research Lab., Tokyo), Toshio Kawai, Junichi Miida, Nobuhide Suda, Shigehiro An, and Akira Oyama. May 1964. 16p.

A theoretical dynamic analysis of boiling water reactors and an analysis of multiregion reactor kinetics are presented. The derivation of the equations describing the transient void formation in the core is discussed, and these equations are simplified and combined with other equations to form a complete mathematical model of the boiling water reactors. Finally, using the model, the reactor stability is investigated. (auth)

38330 (A/CONF.28/P/848) KINETIC STUDIES AND CONTROL OF NUCLEAR REACTORS BY STATISTICAL METHODS. Yoshiteru Kuroda (Tokai Univ., Tokyo), Shuji Yamada, Tsutomu Nomura, Seiichiro Goto, Junichi Miida, Kenji Sumita, Masao Haro, Nobuhide Suda, Yoshizo Takahashi, and Shigeyuki Takamatsu. May 1964. 20p.

The statistical analyses of nuclear reactors are given by both direct power spectrum measurement and cross-correlation methods using binary noise. The experimental and analytical studies of reactor kinetics by those methods are summarized, with a special emphasis placed on noise spectrum of various reactors at critical and subcritical states by direct measurement and on the development of binary noise techniques. The automatic start up of a research reactor by digital method is described. (auth)

38331 (A/CONF.28/P/871) ROSPO— ORGANIC MODERATED CRITICAL EXPERIMENTS. G. Bitelli (Italy. Comitato Nazionale per l'Energia Nucleare, Rome), G. Gambardella, R. Martinelli, S. Nicosia, F. Orestano, A. Pulacci, E. Santandrea, P. Saya, and R. Zona. May 1964. 16p.

ROSPO is a critical facility built for the PRO project to test organic moderated cores. Descriptions are given of the reactor systems, instrumentation, control, etc. The first phase of the experimental program is outlined, and results are presented for three cores with different uranium-stainless steel ratios in the fuel elements. (D.L.C.)

38332 (A/CONF.28/P/878) EXPERIMENTAL STUDY OF CRITICAL SYSTEMS WITH Li^7H AND $ZrH_{1.6}$ MODERATORS. V. A. Kuznetsov, Y. A. Prokhorov, I. I. Zakharkin, I. E. Somov, and V. G. Maltsev (U.S.S.R.). May 1964. 18p.

Critical parameters were determined experimentally and corrections were considered for lithium-hydride and zirconium-hydride moderators on the PF-4 zero-power assembly. Neutron energy spectra were measured in the critical assembly with zirconium hydride moderator; from given flux distributions, it is concluded that neutron density can not be described in terms of a Maxwell distribution. (M.J.T.)

38333 (IDO-16989) SELF-LIMITING EXCURSION TESTS OF A HIGHLY ENRICHED PLATE-TYPE D_2O-MODERATED REACTOR. PART III. EFFECT OF SYSTEM TEMPERATURE. R. C. Schmitt and J. E. Grund (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). July 1964. Contract AT(10-1)-205. 39p.

Self-limiting power excursion tests were performed to investigate the effect of initial system temperature on the dynamic response of the Spert II Expanded Core. This D_2O-moderated core was comprised of 3-inch square by 24-inch long, highly enriched, uranium–aluminum, plate-type fuel assemblies spaced on six-inch centers. The power excursions were initiated by step reactivity insertions with the system at various initial temperatures, near atmospheric pressure, with no forced coolant flow, and both with

and without a moderator expansion space (gas dome) in the reactor vessel. The reactivity insertions ranged from about 50 cents to 3.7 dollars and resulted in initial asymptotic reactor periods from about 5 sec to 37 msec. These tests demonstrated that increasing the initial system temperature toward the system saturation temperature permits steam formation to occur earlier than in comparative ambient temperature or pressurized tests. The increased dependence on steam formation for shutdown was reflected in a reduction in peak powers, energy releases, and fuel plate surface temperature rises. Also demonstrated was an increased margin of safety to the reactor. With the system at higher initial temperatures, larger reactivity additions could be safely withstood without damage to the core. Whereas earlier work has indicated that the onset of core damage occurred for ambient temperature tests with initial periods of about 70 msec, tests with the system temperature at 100°C and having asymptotic periods as short as 37 msec were successfully conducted in this test series without observable core damage. (auth)

38334 (TID-20933) THE SPHERICAL HARMONICS METHOD FOR CRITICAL SPHERES (thesis). James Donald Callen (Kansas State Univ., Manhattan. Engineering Experiment Station). 1964. 136p.

Kansas State Univ. Eng. Expt. St., Spec. Rept. No. 46.

The theory, including all four sets of vacuum-interface boundary conditions and computer programs, and the nature of the convergence of the even- and odd-order spherical harmonics approximations to the Boltzmann neutron transport equation for exact critical size for various boundary conditions applied to a spherical reactor are discussed. Special emphasis is placed on development of the theory for even-order approximations. (auth)

38335 MEASUREMENTS OF NEUTRON TEMPERATURE IN SYSTEM ZR-2. Geza Szerphalmi, László Turi, and József Vigassy (MTA Kozponti Fizikai Kutatointezet, Budapest). Energia Atomtech., 17: 146-52(Mar. 1964). (In Hungarian)

After reviewing the main methods used for the determination of neutron spectra of reactors, neutron spectrum measurements carried out with the critical assembly (zero-power reactor) ZR-2 are discussed. The fuel elements of the system consisted of 10% enriched UO_2 in a Mg system, clad with Al; natural water served as moderator and reflector. Three different lattice arrangements were used for the measurements which included the determination of the reactivity change caused by Cd, B, Dy and Ag specimens introduced into the assembly as aqueous solutions of $Cd(NO_3)_2$, H_3BO_3, $Dy(NO_3)_2$ and $AgNO_3$ in Plexiglas containers. The reactivity change due to the absorbent was calculated from the measured change in the asymptotic period of the system brought to the supercritical state; the concentration of the solution was so chosen that reactivity change values of about 4×10^{-4} were obtained. The results differed from those of similar experiments carried out with the VVR-S type reactor having a similar spectrum and burnout; this is probably due to differences in the experimental technique. (TTT)

38336 HARMONIC ANALYSIS OF THE INSTANTANEOUS COUNTING RATE OF A SAMPLE OF RANDOM PULSE FLOW. J. Freycenon (CEN, Saclay, France). J. Nucl. Energy, Pts. A & B, 18: 387-99(July 1964). (In French)

A brief description is given of the periodic sampling process of a flow of random pulses from a nuclear reactor. The systematic errors due to the Fourier analysis leading to the knowledge of the spectral components of the instantaneous counting rate are considered. It is shown that besides the Nyquist theorem relative to the folding of the spectrum, the integration caused by the sampling introduces $\sin \alpha/\alpha$ correcting terms which cannot be neglected. It is shown that the theoretical knowledge (or the measurement) of the autocorrelation function of the statistical fluctuations superposed on the analyzed signal, allows the computation of the variance of the spectral components determined by Fourier analysis. A simple numerical example shows that it is necessary to record 8×10^6 pulses to obtain a 1 per cent precision on the amplitude measurement of a signal which is 1 per cent of the mean counting rate (assumed to follow a Poisson distribution law). (auth)

38337 CONTROL AND INSTRUMENTATION. W. C. Lipinski, J. M. Harrer, and R. L. Ramp (Argonne National Lab., Ill.). p.346-400 of "Reactor Handbook. Second Edition, Revised and Enlarged. Vol. IV. Engineering." New York, Interscience Publishers, 1964.

Reactor self-regulation through the inherent reactivity stabilizing effect of temperature on pressurized reactors and of moderator void on boiling reactors was studied, and such features included in existing plants are described. A discussion of reactor time-dependent behavior is included. (R.E.U.)

Design and Feasibility

38338 (A/CONF.28/P/41) THE FAST NEUTRON REACTOR SERIES IN FRANCE. G. Vendryes (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 17p.

The development program for plutonium-fueled fast reactors in France is outlined; a central power station of 100 Mw(e) is described. Economics of fast reactors is discussed. (R.E.U.)

38339 (A/CONF.28/P/51) A STUDY OF NEW STRUCTURES ADOPTED TO GAS-GRAPHITE AND GAS-HEAVY WATER REACTORS. Roger Martin and Roland Roche (Commissariat à l'Énergie Atomique, Paris). May 1964. 15p.

The adoption of an annular fuel element and of a downcurrent cooling will make it possible to increase the specific power and the power output of each channel; as a result there will be a considerable reduction in the number of the graphite channels and a corresponding increase in the size of the unit cell. The use of prestressed concrete for the construction of the heavy water reactor vessel is becoming more widespread; this could lead to the exchangers and the fuel-handling apparatus becoming integrated inside the vessel. The use of horizontal pressure tubes for the gas-heavy-water system and the use of a prestressed concrete vessel for the gas-graphite system are analysed. (auth)

38340 (A/CONF.28/P/364) SOME NEW ASPECTS OF THE APPLICATION OF THE ADJOINT FUNCTIONS AND OF THE PERTURBATION THEORY IN REACTOR AND SHIELDING CALCULATIONS. A. A. Abagian, G. I. Drujinina, A. A. Dubinin, S. M. Zaritsky, V. V. Orlov, V. Ya. Pupko, A. P. Suvorov, L. N. Usachev, and R. P. Fedorenko (U.S.S.R.). May 1964. 19p.

An application of perturbation theory is considered in which not only reactivity changes but also variations of a number of other reactor characteristics represented as a ratio of any two values of neutron-induced processes in a reactor can be obtained. The computation algorithm is described, and some applications of this perturbation theory are given. The adjoint equations and perturbation

theory technique are applied to find the minima of the reactor critical mass in the general case. The concept of the efficiency function of fissionable material in the reactor is considered. The material efficiency concept and the corresponding algorithm for the determination of the optimal distribution of material can be extended to other reactor materials (moderator, absorber, ^{238}U distribution in a breeder reactor). The applications of non-homogeneous adjoint equations to the investigation and design of radiation shielding are considered. The perturbation theory formulas for the most general case of medium and source parameter changes are derived. The efficiency function concept of shielding material for various processes in shielding is introduced, and the condition of optimal shielding material distribution is formulated. (M.J.T.)

38341 (A/CONF.28/P/373) THE CALCULATION OF THE THERMAL UTILIZATION IN CELLS WITH COMPLEX FUEL ELEMENTS. G. A. Bat, E. A. Grigoreva, V. N. Lebedev, A. I. Prokhorov, and L. S. Tzygankov (U.S.S.R.). May 1964. 18p.

Core lattices of many reactors contain, instead of individual cylindrical fuel elements, bunches of elements-channels surrounded by a layer of moderating material, which is longer than the free path of thermal neutrons. Thus the reactors of ice-breaker Lenin, and physical and technical research reactor RFT have the canal structure. If the channel is split into a small number of cores it might lead to a considerable error in the calculations of thermal neutrons utilization coefficient. If one takes into account the channel structure and the change of its composition in the process of burning-out, and has to use finite difference methods with several scores of nodes along the cell radius. Application of artificial methods, such as integral method of Amuajal and Benua, is practically impossible. Solution of kinetic equation by expanding into spherical harmonics does not ensure the required accuracy if there is a thin absorber-type control rod inside the channel. The Monte-Carlo method is probably possible only for the channels with low symmetry, such as first atomic power station channels. The methods of characteristics (Vladimirov) and of S_n (Carlson) seem to be more convenient for the symmetrical cells. The computation time is greatly increased by combining the most precise possible account of thermalization and kinetic effects in one program for the geometrically complex cells. It is rational to analyze the thermalization separately, in diffusion approximation, and to use the obtained spectra for averaging cross sections. Thus the problem is reduced to a solution of a single-velocity kinetic equation with cross sections which are piece by piece continuous as functions of co-ordinates. A description is given of a diagram and of a program of this type of calculation. The estimation of thermalization effects is based on assumptions of Maxwellian, with variable temperature, nature of thermal neutron spectrum in the moderator, and of absence of energy exchange between neutrons and fuel nuclei. The kinetic equation is solved by means of a somewhat modified method of characteristics. The number of characteristics may be less than that of the nodes along the radius. The data of P_1 or P_3 solutions are used as the first approximation. Iterations are done only externally, over the source. The diagram is approved of by comparing the results with the known data, including the experimental data for simple uranium–water lattices. In this case the coincidence turns out to be better than satisfactory. In case of multi-layer cells the analyses of flux distribution and of thermal neutrons utilization coefficient values, obtained by P_1, P_3, and S_n methods as well, make it possible to arrive at a conclusion as to the necessary detailed structure of cell geometry and to the required accuracy of equation solution. (auth)

38342 (A/CONF.28/P/375) EXPERIMENTAL STUDY OF SOME METHODS OF COMPENSATING EXCESS REACTIVITY IN INTERMEDIATE REACTORS. V. A. Kuznetsov, A. I. Mogilner, L. A. Chernov, V. V. Chekunov, and V. I. Sharadin (U.S.S.R.). May 1964. 20p.

Results are presented of experimental investigations of the methods of compensation of high-excess reactivity by separating two halves of the core or by inserting compensating cylinders enclosed in boron-containing material into a side beryllium reflector. The efficiency of these methods of compensation is compared with that of a single boron-carbide rod placed in the center of the core. The distortion of the neutron density distribution is presented as a function of the angular position of the recompensation cylinder and of the separation between two halves of the core. An attempt was made to evaluate the efficiency of separating halves of the core for intermediate reactors by numerical computations based on one-group theory. The results of the investigation of the absorbing rods interference prove that the main contribution to the interference comes from pair interactions. The experimental data permit evaluation of the efficiency of the absorbing rod system. The experiments were carried out with beryllium-moderated intermediate zero-power reactors on the PF-4 physical assembly. (auth)

38343 (A/CONF.28/P/538) THE MOSEL REACTOR CONCEPT. Paul R. Kasten (Kernforschungsanlage. Institut fur Reaktorentwicklung, Julich, Germany). May 1964. 18p.

The Molten Salt Epithermal Reactor concept, which comprises a two-fluid, two-region reactor using thorium and uranium fluorides dissolved in molten fluoride salts, is discussed, including the properties and corrosive effects of molten salts, core heat transfer design, reactor physics, fuel recycle, and fuel and power costs. (D.C.W.)

38344 (A/CONF.28/P/845) SOME ASPECTS OF REACTOR ANALYSIS. PART I. REMARKS ON THE THEORETICAL TREATMENT OF A HOMOGENEOUS SYSTEM. Jitsuya Hirota (Japan Atomic Energy Research Inst., Tokyo) and Satoru Katsuragi. PART II. AN ADVANCEMENT ON THE INTEGRAL TRANSPORT THEORY FOR THE HETEROGENEOUS SYSTEM. Yuzo Fukai, Ichiro Komatsu, Hiroshi Takahashi, and Takashi Nakayama. May 1964. 17p.

A series of critical experiments and theoretical analyses were made on two-region systems in which a heavy water solution of uranyl sulfate (^{235}U enrichment about 20 per cent) is surrounded by heavy water, poisoned with boron or mixed with thorium oxide. In the analysis of these systems, leakage of fast neutrons from the core and competition of the leakage with resonance absorption in the core are important. To take these effects into consideration, it is required to adopt a multigroup model. For systems with a high fuel concentration, the spatial dependence of the spectrum becomes significant. The thermal flux distribution varies rather sensitively with the effective cross section adopted in calculation. Each region should be divided into many subregions with different effective cross sections. The effective multiplication factor is reduced by the rigorous treatment of the fast neutron leakage from the core, and is increased by using space-dependent effective cross sections. Any disagreement in the effective multiplication factor found between the theoretical and ex-

perimental values might be attributed to uncertainties in the resonance integral of ^{235}U. These analyses suggest that the accepted value of $\nu I_f - I_a$ is about 50 b too large. The effective multiplication factors are affected to some extent by the resonance integral of thorium. The integral neutron transport theory has been accorded more importance in calculations of heterogeneous reactors than the differential theory, for its applicability to more complex systems. The effect of anisotropic scattering by the moderator atom on the flux ratio of the moderator to the fuel in the slab lattice is intensively studied, and the propriety of approximation by replacing the total cross section of the moderator by the transport cross section is investigated. Exact expressions of first flight collision probability in the hexagonal and square lattices are derived to remove the error introduced by the cylindrical cell approximation. Although it has hitherto been believed to be difficult to obtain by the integral transport theory the collision probability in these lattices with anisotropic scattering, formulation of the probability is succeeded in the case of a cylindricalized lattice. The factorization method in calculations of the thermal neutron spectrum is extended to the case of the integral transport equation, and the calculation method of fast fission effect without iteration is discussed in comparison with the Monte Carlo method. (auth)

38345 (A/CONF.28/P/858) NEUTRON MEASUREMENTS INSIDE REACTORS WITH SEMICONDUCTOR COUNTERS. V. Ajdacic, B. Lalovic, M. Barucija, and B. Petrovic (Institut za Nuklearne Nauke "Boris Kidric," Belgrade). May 1964. 15p.

In papers describing the first counting method, the "long-tube" method was considered, which enables simple and direct measurements of high neutron fluxes inside the reactor core. A 6-meter evacuated aluminum tube, which is inserted into the reactor core, is used. A target made of fissile materials, ^{6}Li, or ^{10}B is placed at the bottom of the tube. At the other end of the tube, outside the core, a semiconductor counter is mounted to detect fission fragments or heavy particles coming from the target caused by neutron-induced reactions. Thus, it was shown that high counting rates of neutron reaction products can be achieved with ^{235}U, ^{239}Pu, ^{6}Li, and ^{10}B targets placed inside the reactor core. To extend this method to absolute measurements of high neutron fluxes, parameters were measured defining the observed yield of reactions. With respect to the effect of particle scattering, special care was taken in choosing the most suitable geometry of the experiment, target-collimator-counter. An additional aluminum tube with a transistor preamplifier and a semiconductor counter at one end is used to vary the distance between the counter and the target. The yield of the scattered particles was observed with collimators and counters of different diameters. With a collimator 1 cm in diameter, placed 2 m away from the target a fission spectrum was obtained almost identical with the spectrum usually observed with semiconductor counters. This proved that scattering of fragments from the walls of the tube which previously had caused deformation of fission spectra, was eliminated. By this method and with ^{235}U target, absolute measurements of thermal neutron fluxes in the Vinča heavy water moderated reactor operating at 6.5 Mw were made. The estimated accuracy of the method was about 4%. Possible applications of this method were discussed for neutron flux measurements in advanced reactors with super high neutron fluxes of 10^{15} to 10^{16} n/cm^2 sec. This application is based on the counting rate for the given detector position decreasing with time, which is caused by the burn-up of the high cross-section target. Fast neutron spectra inside the Vinča reactor were measured using semiconductor counters and a ^{6}Li target. A new detector-target arrangement was employed, in which only those products of the $^{6}Li(n,\alpha)T$ reactions, whose mutual angle of emission is different from 180°, are detected in coincidence. In this way the thermal neutron interference is completely suppressed. Resolution of the spectrometer as a function of the reactor power and correction factors of the spectrometer efficiency for various neutron energies are presented. Direct comparison with the sandwich-target geometry shows some advantages of a new detector-target arrangement for measuring fast neutron spectra inside well-moderated low-power assemblies. (auth)

38346 HEAT TRANSFER STUDIES ON ORGANIC COOLANTS. I. Szentgyoergyi (Central Research Inst for Physics, Budapest). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 309-22(1961).

Experiments were performed to improve heat transfer properties of organic coolants and examine nucleate boiling heat exchange. Suspension tests were carried out using graphite and aluminum dispersed in eutectic of 73.5% biphenyl oxide and 26.5% biphenyl. It was found that the increase in thermal conductivity was offset by the increase in viscosity. The nucleate boiling experimental apparatus is described, but thermocouple and other deficiencies appeared which affected the accuracy of the measurements. Safety measures against burnout are described. Results indicate that heat transfer rates are not as high as for water convection. (T.R.H.)

38347 HETEROGENEOUS WATER COOLED REACTORS. Harold Walchli (Westinghouse Electric Corp., Pittsburgh) and John M. West. p.548-611 of "Reactor Handbook. Second Edition, Revised and Enlarged. Vol. IV. Engineering." New York, Interscience Publishers, 1964.

Specific design details on pressurized light and boiling water reactors are presented with some descriptive data on pool- and tank-type reactors and on the production reactors at Hanford and Savannah River. A bibliography of 119 references is included. (R.E.U.)

38348 LIQUID METAL COOLED REACTORS. L. E. Crean and W. E. Parkins (Atomics International, Canoga Park, Calif.). p.612-81 of "Reactor Handbook. Second Edition, Revised and Enlarged. Vol. IV. Engineering." New York, Interscience Publishers, 1964.

Problems associated with the use of liquid metals as heat transfer media in nuclear systems are discussed. The advantages and disadvantages of the liquid metals as coolants are discussed, with emphasis on Na and NaK systems. The problems include mechanical, metallurgical, and operational aspects of structural materials, fuels, moderators, control and safety elements, pumps, piping, valves, heat exchangers, steam generators, traps, and instrumentation. Brief descriptions of the principles of liquid metal-cooled reactors are given. (R.E.U.)

38349 GAS COOLED REACTORS. C. S. Lankton (General Electric Co., Cincinnati). p.682-721 of "Reactor Handbook. Second Edition, Revised and Enlarged. Vol. IV. Engineering." New York, Interscience Publishers, 1964.

Basic design principles of gas cooled reactors are discussed. Nuclear problems and thermodynamic performance are considered. Specific reactors and conceptual designs are discussed. (R.E.U.)

38350 AQUEOUS FUEL REACTORS. James A. Lane (Oak Ridge National Lab., Tenn.). p.722-65 of "Reactor

Handbook. Second Edition, Revised and Enlarged. Vol. IV. Engineering." New York, Interscience Publishers, 1964.

Characteristics of circulating nonboiling fluid fuel reactors are discussed. Plant layout and design and reactor operational techniques are discussed. Some specific reactor designs are considered. A bibliography of 115 references is included. (R.E.U.)

38351 LIQUID METAL FUEL REACTORS. David H. Gurinsky (Brookhaven National Lab., Upton, N. Y.). p.766-804 of "Reactor Handbook. Second Edition, Revised and Enlarged. Vol. IV. Engineering." New York, Interscience Publishers, 1964.

Potential advantages and disadvantages of liquid-metal-fuel reactors are discussed. Materials and engineering design are considered. Design of the Brookhaven LMFR is described. A bibliography of 115 references is included. (R.E.U.)

38352 MOLTEN SALT REACTORS. H. G. MacPherson (Oak Ridge National Lab., Tenn.). p.805-44 of "Reactor Handbook. Second Edition, Revised and Enlarged. Vol. IV. Engineering." New York, Interscience Publishers, 1964.

General characteristics of molten salt fuel reactors are discussed. Materials of construction, pumps, and miscellaneous components are reviewed. The Aircraft Reactor Experiment is discussed. (R.E.U.)

38353 SUBCOOLED LIQUID INLET FOG COOLED NUCLEAR REACTORS. M. Raber and G. A. Sofer (to U. S. Atomic Energy Commission). U. S. Patent 3,144,393. Aug. 11, 1964.

A light water moderated fog-cooled nuclear reactor is designed in which sub-cooled water is delivered to the core and the fog flow regime is maintained throughout most of the length of the core. Separation of the water in the coolant tubes from the moderator water outside is such that the bulk of moderation occurs in the outside water. Another feature of this reactor is individual compact water separation devices for each of the coolant channels with the core. (AEC)

Fuels

Refer also to abstracts 37606, 37614, and 37869.

38354 (A/CONF.28/P/26) FUEL BURNUP AND REACTIVITY CHANGES. M. F. Duret (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.), R. W. Durham, M. Lounsbury, A. Okazaki, W. H. Walker, A. G. Ward, and L. Pease. May 1964. 15p.

AECL methods for calculating fuel burnup and experimental measurements supporting the analysis are reviewed. The burnup estimate for natural-uranium-fueled reactors is a synthesis of a wide range of information, including detailed nuclear cross-section data, information from lattice experiments, and measurements of fission-product poisoning and reactivity change with irradiation. The estimate is based on a simple credit and debit balance for neutrons; changes in the estimate reflect changes in the entries. Burnup estimates are particularly sensitive to the nuclear parameters of uranium-235 and plutonium-239, and to the neutron absorption in fission products. Methods of calculating reactivity-limited fuel burnup are evaluated. (N.W.R.)

38355 (A/CONF.28/P/60) RECENT DEVELOPMENTS CONCERNING FRENCH FUEL ELEMENTS FOR NATURAL URANIUM–GRAPHITE–CO_2 REACTORS. Max Salesse, Jacques Stohr, and Guy Jeanpierre (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 13p.

A tubular uranium element closed at both ends and cooled externally, chosen for the reactors EDF-2, EDF-3, and EDF-4, makes it possible to attain maximum specific powers of the order of 6 Mw/metric ton. An open tubular uranium element cooled both internally and externally is being studied as a possibility for EDF-5. Such an element makes it possible to attain specific powers of over 12 Mw/metric ton. The two types of element have, for external cooling, herring-bone type fins. The fuel rods are placed inside graphite jackets, thus limiting the vertical forces and protecting them during charging and discharging. (auth)

38356 (A/CONF.28/P/65) THE PROCESSING OF IRRADIATED FUELS—IMPROVEMENT AND EXTENSION OF THE SOLVENT PROCESS. Pierre Faugeras and André Chesne (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 18p.

Improvements made in the conventional tributylphosphate process are described, in particular: the concentration and the purification of plutonium by one extraction cycle using tributylphosphate with reflux; and the use of an apparatus working continuously for precipitating plutonium oxalate, for calcining the oxalate, and for fluorinating the oxide. The modifications proposed for the treatment of irradiated uranium–molybdenum alloys are described, in particular, the dissolution of the fuel, and the concentration of the fission product solutions. The solvent extraction treatment is used also for the plutonium fuels utilized for the fast breeder reactor (Rapsodie). An outline of the process is presented and discussed, as well as the first experimental results and the plans for a pilot plant having a capacity of 1 kg/day. The possible use of trilaurylamine in the plutonium purification cycle is now under consideration for the processing plant at La Hague. The flowsheet for this process and its performance are presented. The possibility of vitrification is considered for the final treatment of the concentrated radioactive wates from the Marcoule (irradiated uranium) and La Hague (irradiated uranium–molybdenum) Centers. Three possible processes are described and discussed, as well as the results obtained from the operation of the corresponding experimental units using tracers. (auth)

38357 (A/CONF.28/P/66) THE PROCESSING OF IRRADIATED FUELS BY THE HALOGENS AND THEIR COMPOUNDS. Michel Bourgeois and Pierre Faugeras (France. Commissariat à l'Energie Atomique, Paris). May 1964. 16p.

Reactor fuels are processed by volatilization of fluorides by gas phase attack. The aluminum or zirconium cladding is first volatilized as chloride by attack with gaseous hydrogen chloride. The uranium is then transformed into volatile hexafluoride by attack with fluorine. These reactions are carried out consecutively in the same reactor in the presence of a fluidized bed of alumina which facilitates heat exchange. The separation of uranium and plutonium fluorides is also described. An apparatus is described for testing the process on irradiated fuel at an activity level of several thousands of curies of fission products. (auth)

38358 (A/CONF.28/P/67) SIX YEARS WORKING EXPERIENCE OF THE MARCOULE REPROCESSING PLANT. Claude Jouannaud (France. Commissariat à l'Energie Atomique, Paris). May 1964. 15p.

The irradiated fuel treatment plant at Marcoule began treating rods from the pile G-1 in July 1958. The process as a whole has suffered little modification. The processes of plutonium reduction from valency IV to III by uranium

(IV), and of concentration of fission product solutions in the presence of formaldehyde, have always given complete satisfaction. Analytical checking in the laboratory was profoundly modified, so that complete safety in work on radioactive solutions is compatible with a good working speed. (auth)

38359 (A/CONF.28/P/147) THE DEVELOPMENT AND EVALUATION OF URANIUM–MAGNOX FUEL ELEMENTS. J. W. Hughes (Nuclear Power Group, Knetsford, Ches., England), G. H. Inglis, C. H. Jones, and J. Price. May 1964. 15p.

The main features of the out-of-pile mechanical development of the magnox-uranium fuel elements for United Kingdom power reactors over the three year period to December 1963 are reviewed. Only the development of the stacked design of element is considered, and the problems associated with gas forces and stacking loads are emphasized. Experimental and analytical techniques developed for the evaluation of fuel element designs are described, and the criteria by which an element is judged acceptable are given. (auth)

38360 (A/CONF.28/P/149) PROGRESS TOWARDS THE DESIGN OF A.G.R. FUEL ELEMENTS FOR POWER REACTORS. G. B. Greenough (United Kingdom Atomic Energy Authority. Reactor Group, Springfields, Lancs, England), J. S. Nairn, and J. D. Thorn. May 1964. 15p.

The advantages to be gained from the standardization of fuel elements for a large number of reactors include savings in fabrication costs owing to unification of manufacturing plant, savings in development costs due to these being shared, and savings in the design and development costs of the reactor plant, owing to the further standardization possible both in components and design treatment. The results of continuing fuel development can be applied to improve the current standard design, and the studies are enhanced in value by being directly applicable in new fuel charges for existing, as well as future, reactors of the type. With the A.G.R. concept, such standardization is possible over a wide range of reactor sizes. The design and development program on A.G.R. fuel assemblies is aimed at the formulation of such a standard concept for power reactor fuel elements, taking the original Windscale A.G.R. fuel design as the starting point. The basis for the selection of parameters and structural design features is discussed including a brief outline of a method for estimating the variations of the can temperature from the nominal in particular cluster designs. A synopsis is given of the data selected as most appropriate for the calculation of gaseous fission products within the can under A.G.R. conditions, this influences the chosen reactor conditions. Out-of-pile work undertaken to sort out the likely behavior of fuel elements and assemblies is described. It includes data on the conditions critical for the appearance of longitudinal wrinkles during creep collapse, and on the behavior of cans under simulated fault conditions. The behavior of different assembly designs during thermal cycling is discussed. A few notes are included on the effect of dropping assemblies. The fuel element irradiation program in W.A.G.R. is described. The correlation of the performance of those already in the reactor with that expected is discussed. A brief description is given of the facilities available for the examination of irradiated elements. The results from the post-irradiation examination of fuel element stringers from W.A.G.R., as well as from certain loop experiments undertaken in NRX under conditions similar to A.G.R., are discussed. The data cover particularly length changes occurring in-pile, fission product gas release and an unusual chemical attack on the inside surfaces of the stainless steel cans. (auth)

38361 (A/CONF.28/P/153) FABRICATION AND IRRADIATION STUDIES OF UO_2–STAINLESS STEEL AND $(U,Pu)O_2$–STAINLESS STEEL CERMETS. B. R. T. Frost (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England), L. H. Cope, J. D. B. Lambert, H. Lloyd, W. Long, J. E. Manson, and P. G. Mardon. May 1964. 15p.

The matrix and cladding materials selected were type 316L steels. Hot swaging techniques were selected for the preparation of fuel pins. Initial efforts were required as far as matrix densification, ceramic distribution, and matrix-to-clad bonding were concerned. A technique was developed to remove these defects; spherical granules of oxide were coated with steel powder, consolidated and sintered, and finally densified and bonded at a high temperature in a multi-die swage. Hot-rolling led to the preparation of dense, bonded plates with fairly uniform ceramic distributions. Fuel pins and plates were irradiated in thermal fluxes in the PLUTO and Dounreay Materials Testing Reactors. Encouraging performances were obtained from pins with better initial structures. Plate specimens with non-uniform ceramic particle distributions achieved 5% burn-up at 650°C surface temperature without failure but swelling was apparent beyond 7% burn-up. The results suggest that the optimum irradiated performance may be achieved by careful control of granule composition and density, and of matrix density and permeability. (auth)

38362 (A/CONF.28/P/154) MONOCARBIDES AS REACTOR FUELS. L. E. Russell (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England), B. T. Bradbury, H. J. Hedger, N. Parkinson, R. G. Sowden, and M. B. Waldron. May 1964. 15p.

Basic studies of the preparation of U–C and (UPu)–C by the carbothermic reduction of UO_2 and $(UPu)O_2$ in vacuum have led to the development of alternative processes for the preparation of carbides. It is now possible to produce fuel pellets of high density by sintering carbide powders in argon or in vacuum at temperatures close to 1500°C. In addition, high density rods are prepared by skull melting and centrifugal casting. These investigations have been supplemented by work on vibratory compaction, gas pressure bonding, and electron beam melting techniques. The suitability of these processes for the preparation of fuel for particular application is discussed and information on changes in plutonium content of (UPu)–C materials during fabrication is presented. The potential of carbides as reactor fuels is considered in the light of recent measurements of physical and chemical properties, phase equilibrium determinations, and the known irradiation behavior. Possible future developments leading to improved irradiation behavior are suggested and some information on the preparation and properties of cemented and bonded carbides, and carbides containing strengthening carbides in solid solution is presented. (auth)

38363 (A/CONF.28/P/438) AN EXPERIMENTAL STUDY ON THE MECHANICAL STRENGTH OF FUEL CLADDING TUBES UNDER LOSS OF COOLANT ACCIDENT CONDITIONS OF WATER COOLED REACTORS. Y. Mishima (Tokyo Univ.), I. Katsura, M. Kosaki, Z. Takao, H. Tanaka, M. Toyoda, S. Wakisada, and M. Yokosuka. May 1964. 20p.

The purpose of the experiment was to review and confirm the mechanical integrity and behavior of fuel element cladding tubes for light water reactors under the loss-of-coolant accident conditions. Accumulation, to a certain extent, of fission gases within fuel elements will not affect cladding tubes as the source of internal pressure while the reactor is under operation, since the coolant outside the tubes offsets it as an external pressure. If the coolant pressure drops by such a reason as the loss-of-coolant accident, however, an effective difference between pressures in and out the tubes rises instantaneously, and this may result in bursting. Temperature rise due to the decay heat after the loss-of-coolant causes internal pressure to rise, which may also result in bursting. Evaluation of fuel cladding safety under simulation of such conditions was made by this experiment. The AISI 304L, 347 stainless steel, and Zircaloy-2 tubes were selected for the testing and their diameter-to-thickness ratios were selected between 12.0 and 28.7. Hydrogen absorbed Zircaloy-2 tube specimens were also selected for evaluating the effect of hydrogen absorption on the mechanical behavior under the accident conditions. The experimental conditions were determined from the analysis of the loss-of-coolant accidents for the typical pressurized as well as boiling water reactors. Experiments were performed under the following conditions: tensile test of the cladding materials at high temperatures up to 700°C, and at the various moderate load rates up to 5.0 kg/mm^2/sec; burst test of the various sized cladding tubes for temperatures ranging from the room temperature up to 700°C; and in the dynamic burst test under the various loss-of-coolant accident conditions, the specimens were internally pressurized to the predetermined value at the surface temperatures between 280 and 450°C and under the external pressure corresponding to the coolant pressure, and then the external pressure was suddenly reduced at the postulated rate for the loss-of-coolant accident. It is concluded from a series of the experiments that the mechanical properties of the cladding tubes are scarcely affected by such a load change of postulated pressure decreasing rate at the loss-of-coolant accident, and also it is experimentally confirmed to be possible to estimate the bursting pressure of the fuel cladding tube from the tensile strength of the materials. Less expansion was observed on the Zircaloy-2 tube after bursting which absorbed about 300 ppm hydrogen, though its tensile strength was found to have changed little. (auth)

38364 (A/CONF.28/P/442) DESIGN AND FABRICATION OF PWR FUEL ELEMENTS IN BELGIUM. M. Huberlant (Metallurgie et Mecanique Nucleaires, S. A., Dessel, Belgium), J. Wertz, A. de Streel, and J. van Mulders. May 1964. 15p.

A discussion is presented of the fabrication and the analysis of the behavior of an experimental fuel element for the BR-3 reactor. The fuel element comprises 108 fuel rods, 12 of which contain plutonium. The analysis of the behavior is performed from the nuclear, hydraulic, and thermal points of view. (D.L.C.)

38365 (A/CONF.28/P/469) EXAMINATION OF AN IN-PILE-BURNOUT DAMAGE ON A BOILING WATER FUEL ROD. R. Schwarzwaelder, J. Hoechel, and J. Fischer (Allgemeine Elektrizitätsgesellschaft, Frankfurt am Main). May 1964. 18p.

During irradiation of fuel rods under boiling water conditions in a capsule in the GETR at Vallecitos, burnout damage due to insufficient cooling was observed on three rods. One rod was subjected to metallographic, gamma activity, and x-ray analyses. The examination showed that there was no reaction between the UO_2 fuel and the stainless steel cladding, although the melted stainless steel was widely dispersed in the fuel, and that there was no vigorous reaction between the stainless steel and the coolant, although strong oxidation of the melted cladding was observed. (D.C.W.)

38366 (A/CONF.28/P/472) RARE GAS RELEASE FROM SOLIDS WITH SPECIAL ATTENTION TO NUCLEAR FUEL MATERIALS (RARE GAS DIFFUSION IN SOLIDS 14). F. Felix, T. Lagerwall, P. Schmeling, and K. E. Zimen (Hahn-Meitner-Institut fur Kernforschung, Berlin). May 1964. 16p.

Neutron irradiation of special solids results in single atoms of rare-gases dispersed in the solid system. By observing the kinetics of the diffusion and final release of the rare-gas atoms, structural and chemical changes during thermal treatment of the solid can be observed and investigated. In fissionable solid materials and at higher burn-up the formation of rare-gas atoms and bubbles implies a mechanical stress of the fuel elements and jackets, and a change of reactivity by the build-up of ^{135}Xe. Investigations are described, which were conducted to study the mechanisms of rare-gas diffusion in and the release from solids. (auth)

38367 (A/CONF.28/P/527) SOME THEORETICAL PROBLEMS OF HEAT CONDUCTION IN REACTOR FUEL ELEMENTS. J. Schmid (Ceskoslovenska Akademie Ved. Ustav Jaderneho Vyzkumu, Rez). May 1964. 18p.

A heat conduction boundary problem of fuel elements with temperature dependent thermal conductivity and with nonlinear boundary conditions of the third and fourth type, i.e., with temperature dependent heat-transfer coefficient or with temperature dependent contact resistance on the interface of two media, is solved. (auth)

38368 (A/CONF.28/P/530) DEVELOPMENT OF CERAMIC NUCLEAR FUEL IN CZECHOSLOVAKIA. D. Jakes and H. Landsperský (Ceskoslovenská Akademie Ved. Ustav Jaderného Výzkumu, Rez). May 1964. 17p.

The development of ceramic nuclear materials in Czechoslovakia started with a concept of the DOR reactor. All basic stages of UO_2 powder preparation were studied beginning with ADU precipitation, drying, heat treatment to give UO_3 or U_3O_8, and also reduction to UO_2. The relations between aggregate structure, specific surface area, and chemical reactivity enable easy control of a preparation process. Sintering of the compacts was studied especially in reduction atmosphere of hydrogen at 1200 to 1800°C. Several theoretical questions concerning ADU structure changes during precipitation and the post-reduction nonstoichiometric oxygen location in UO_2 structure were investigated. Preparation methods of non-pyrophoric uranium powder with well controllable grain size were worked out for the synthesis of other types of ceramic fuels. A process of UO_2-SiO_2 co-reduction with calcium hydride was investigated. Grain growth of the metal phase during heat exposure was measured in a U + UC cermet system. (auth)

38369 (A/CONF.28/P/543) THE DEVELOPMENT OF BERYLLIA-BASED FUELS FOR H.T.G.C. REACTOR SYSTEMS. R. Smith (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). May 1964. 20p.

The potential of beryllium oxide as a fuel diluent in dispersion fuels and as a moderator material was studied. Experiments were in a reactor with all-ceramic core, a ^{235}U/Th cycle, homogeneous fuel particles of $(UTh)O_2$ in a

BeO matrix, CO_2 coolant, and maximum fuel surface temperature of 1000°C. Thermal-stress resistance, fission-product retention, corrosion resistance, irradiation behavior, chemical reprocessing, and fuel cycle costs were considered with relation to fabrication variables, microstructure, temperature, and neutron environment. Fine-grained beryllia (grain size less than 5 microns) should withstand a dose of 2×10^{21} nvt (fast) at 400°C and greater than 10^{22} nvt (fast) at 800°C and above. (M.J.T.)

38370 (A/CONF.28/P/570) FUEL CYCLE COSTS IN NUCLEAR POWER STATIONS. G. B. Scuricini (Italy. Comitato Nazionale per l'Energia Nucleare, Rome), D. Oliva, F. Calori, A. Cherubini, R. Scalliet, A. Baruffa, and M. Willems. May 1964. 20p.

The nuclear power station fuel cycle cost is computed in different ways in the countries where the power stations are developed. A method applied to different reactor types and fuel supply contract in order to obtain results of the same approximation degree is presented. The fuel cycle costs along the life of the power station are presented for different reactor types; an evaluation of the marginal cost is outlined. (auth)

38371 (A/CONF.28/P/630) ON SOME PHYSICAL PROBLEMS OF URANIUM BURN-UP IN HEAVY WATER REACTORS. V. Bartosek, M. Hron, V. Lelek, and M. Neprasova (Ceskoslovenska Akademie Ved. Ustav Jaderneho Vyzkumu, Rez). May 1964. 18p.

The burnout of reactor fuel was theoretically investigated for a variety of fuel replacement schemes and schedules. The dependence of the multiplication coefficient on irradiation was considered carefully. (D.C.W.)

38372 (A/CONF.28/P/716) FUEL ELEMENTS IN THE FORM OF CONCENTRIC CYLINDRICAL PLATES (CONCENTRIC TUBE FUEL ELEMENTS). J. Planquart (Centre d'Etude l'Energie Nucleaire, Brussels), M. Huberlant, F. Mathieu, D. Tytgat, and P. De Meester. May 1964. 16p.

Fuel elements, containing enriched uranium, in the form of concentric cylindrical plates or tubes and cooled by water, as in the BR-2 reactor, are evaluated. The fuel element is examined with respect to the problems of manufacture, testing, and commissioning. The fuel element developed for the ESSOR Reactor is described. (auth)

38373 (BAW-3125-1) NON-UNIFORM TEMPERATURE RESONANCE ABSORPTION EXPERIMENT. Quarterly Progress Report No. 1, March 15–June 30, 1964. W. G. Pettus and M. N. Baldwin (Babcock and Wilcox Co. Critical Experiment Lab., Lynchburg, Va.). Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(30-1)-3125-1. 19p. (EURAEC-1146)

An experimental investigation on the effect of non-uniform temperature distributions on the neutron resonance capture integral of thorium metal and oxide rods is in progress. Activities have been devoted primarily to sample procurement, thermal calculations, and apparatus design and development. A thorium metal sample has been fabricated, and ThO_2 pellet samples are being fabricated. These samples, approximately $\frac{3}{4}$ inch in diameter by 6 inches long, contain holes for an axial heater and a thermocouple. A cooling jacket and an inert atmosphere containment are being constructed to allow in-pile operation having radial temperature drops up to 1000°C. (auth)

38374 FUEL ELEMENT DESIGN. C. E. Weber, M. Balicki, and W. Margulis (Knolls Atomic Power Lab., Schenectady, N. Y.). p.155-261 of "Reactor Handbook. Second Edition, Revised and Enlarged. Vol. IV. Engineering." New York, Interscience Publishers, 1964.

The state-of-the-art and geometries advanced, factors important in fuel element design, and specific fuel elements for heterogeneous reactors are discussed. A bibliography of 176 references is included. (R.E.U.)

38375 FUEL ELEMENTS FOR NUCLEAR REACTORS. Charles Herbert Quinton Fifield (to United Kingdom Atomic Energy Authority). U. S. Patent 3,144,394. Aug. 11, 1964. Priority date May 4, 1962, Great Britain.

A finned fuel element with attached thermocouple means is designed for gas-cooled reactors. The fuel element has a small device for applying torsion to the thermocouple cable in order to cut it so that the fuel element may be unloaded from the reactor. (D.L.C.)

38376 FUEL ASSEMBLY FOR LOW POWER REACTORS. Edward F. Groh (to U. S. Atomic Energy Commission). U. S. Patent 3,145,151. Aug. 18, 1964.

A fuel assembly for low power nuclear reactors is designed in which fuel plate assemblies are assembled entirely by hand without a need for skilled labor such as welders. The fuel plates are a sealed sandwich about ten thousandths of an inch thick. Several of these and/or poison plates are enclosed in a pair of longitudinally folded plate clips which are assembled on pins inserted in end fittings. Space is provided for moderator circulation. All components are reusable; the fuel plate assemblies may be altered from time to time by changing fuels and poisons as desired. (AEC)

38377 FUEL ELEMENT. Peter Fortescue, Lloyd R. Zumwalt, and David C. Morse (to U. S. Atomic Energy Commission). U. S. Patent 3,146,173. Aug. 25, 1964.

A fuel element for a nuclear reactor is designed with means for attenuating the migration of fission products therefrom. The means comprises inner and outer concentric containers of low permeability graphite having a plurality of purge channels between the walls of said containers, the outer container having a purge gas region and gas-porous inlet adjacent its upper end and purge gas outlet adjacent its lower end. The inner container has a gas-porous inlet at its upper end and a porous gas outlet at its lower end and contains fuel compacts having a central passageway whereby fission products are transported to the lower portion of said inner container so as to substantially reduce back diffusion of the gaseous and volatile fission products. (AEC)

Power and Power-Breeder Reactors

Refer also to abstracts 37393, 37470, 37646, and 37870.

38378 (A/CONF.28/P/1) ELECTRICITY SUPPLY IN CANADA AND THE ROLE OF NUCLEAR POWER. W. B. Lewis and T. G. Church (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.). May 1964. 21p.

The electrical demand and supply in Canada is discussed, and the present and future roles of nuclear power plants are indicated. The economics of fuel cycles at present and for future applications is considered. (R.E.U.)

38379 (A/CONF.28/P/6) STUDIES OF CANDU-TYPE REACTORS IN THE 500-Mw(e) RANGE. I. L. Wilson (Atomic Energy of Canada Ltd. [Nuclear Power Plant Div.], Toronto), C. E. Beynon, W. G. Morison, and N. L. Williams. May 1964. 13p.

Designs and cost estimates for 500-Mw(e) power

plants of the NPD- and Douglas point-types are discussed. The multi-unit reactor plants are of the heavy-water-moderated and -cooled type fueled with natural uranium (UO_2) in pressure tubes. The plants are expected to be economically competitive with Ontario Hydro power (4.0 mills/kwh). (R.E.U.)

38380 (A/CONF.28/P/7) MANUFACTURING AND CONSTRUCTION FOR THE DOUGLAS POINT NUCLEAR POWER PROJECT. L. J. Ingolfsrud (Atomic Energy of Canada Ltd. [Nuclear Power Plant Div.], Toronto), P. H. G. Spray, and J. H. Jackson. May 1964. 15p.

The Douglas Point power reactor is described with emphasis on construction and steam-raising components. (R.E.U.)

38381 (A/CONF.28/P/10) PROSPECTIVE D_2O-MODERATED POWER REACTORS. G. A. Pon (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.), W. B. Lewis, L. R. Haywood, D. B. Primeau, G. J. Phillips, and E. E. Merlo. May 1964. 13p.

The results of economic and technical assessments of some 450-Mwe, heavy-water moderated reactors cooled by heavy water, boiling heavy water, organic liquids, and boiling light water are presented. Natural uranium, enriched uranium, and uranium alloys were considered as fuels, together with a Th–^{235}U cycle. (D.C.W.)

38382 (A/CONF.28/P/11) ANALYSIS OF CAPITAL COSTS FOR NUCLEAR POWER PLANTS. P. H. G. Spray (Atomic Energy of Canada Ltd. [Nuclear Power Plant Div.], Toronto), H. B. Merlin, L. R. Haywood, J. L. Olsen, and J. O. Holt. May 1964. 9p.

The system of accounts used in Canada for costing nuclear power plants is outlined; and the items included in the capital-cost estimates are discussed, using a typical break down of costs for large two-unit stations as an illustration. The estimated capital-cost distribution for the Douglas Point plant is included. (D.C.W.)

38383 (A/CONF.28/P/18) ENGINEERING AND PERFORMANCE OF UO_2 FUEL ASSEMBLIES. R. D. Page (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.), D. G. Hardy, A. J. Mooradian, J. Howieson, G. R. Fanjoy, and D. B. Nazzer. May 1964. 12p.

The fuel designs developed for the NPD and CANDU reactors are discussed. The reasons for selection of various important parameters are outlined. Neutron economy in design, hydralic and thermal requirements, irradiation tests, and costs are considered. (C.E.S.)

38384 (A/CONF.28/P/29) THE MANAGEMENT OF HEAVY WATER FOR RESEARCH AND POWER REACTORS. J. A. Morrison (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.), M. H. Thomas, L. C. Watson, and L. W. Woodhead. May 1964. 12p.

Provisions made to recover heavy water that escapes from reactor systems and to reconcentrate it are discussed. The problems, including those involving the radioisotope tritium, encountered in the reclamation operations are considered. Sources of downgraded heavy water, purification, isotopic reconcentration, isotopic and chemical analyses, and radiation hazards are discussed. (C.E.S.)

38385 (A/CONF.28/P/31) THE FRENCH NUCLEAR POWER PROGRAMME. Jean Cabanius (France. Electricité de France, Paris), and Jules Horowitz. May 1964. 10p.

The prospects of development of France's consumption of electricity will widen the deficit of her national energy resources. Nuclear power stations should enable this deficit to be reduced, provided a certain number of uncertainties prevailing today are resolved. The first program aimed at commissioning 850 Mwe by 1965; the program was devoted to developing the natural uranium-graphite-gas sequence and reaches its completion with the construction of EDF 3, the world's first unit capable of 500 Mwe. Before changing over from the prototype stage to their duplication, Electricité de France decided, in agreement with the Commissariat à l'Energie Atomique to build EDF 4, which, while reproducing EDF 3's reactor, together with the refueling equipment, the entire control equipment, and various other systems, pioneers an important innovation by incorporating the heat exchangers and fans inside the prestressed concrete pressure-vessel housing the core. At the same time, studies are being carried on the same type of reactor enabling possible use of a new annular-shaped fuel element, whose use would considerably improve the performance of EDF 5, to be envisaged. On the heavy water side, the construction of EL 4 at Brennilis jointly by the Commissariat à l'Energie Atomique and Electricité de France is continuing. Design work on a 500 Mwe reactor of this type has already started. As regards pressurized water reactors, the Chooz power station is built jointly by Electricité de France and Belgian Utilities. Finally, the Commissariat à l'Energie Atomique is continuing the construction of the Rapsodie rapid neutron reactor at Cadarache, together with studies on a larger power reactor. It may thus be seen that the technical and economic knowledge gained on these various types of reactor mean that an equipment program may be contemplated which will endow nuclear power stations with a place of ever-increasing importance, by using the country's resources of natural uranium, and later plutonium, to the best ends. (auth)

38386 (A/CONF.28/P/36) THE DEVELOPMENT OF NATURAL URANIUM–GRAPHITE REACTORS. Jacques Bourgeois (France. Commissariat à l'Énergie Atomique, Paris) and Boris Saitcevsky. May 1964. 20p.

The development of power reactors using the natural uranium–CO_2–graphite system is discussed, with particular emphasis on the annular fuel element which permits an increase in gas pressure. The main characteristics of a possible 500-Mwe power station using such elements are given. The power plant offers a gain of 3.5 in specific power and an increase by 10 of the power per channel, as compared with the EDF1 reactor. (D.C.W.)

38387 (A/CONF.28/P/37) ECONOMIC OUTLOOK ON NATURAL URANIUM–GRAPHITE–GAS–NUCLEAR REACTORS. PRESENT CONDITIONS AND TREND OF COSTS IN FRANCE. Jacques Gaussens (France. Commissariat à l'Énergie Atomique, Paris); Pierre Tanguy, and Bertrand Leo. May 1964. 14p.

The ready availability and storage of natural uranium are indicated; and the fuel operation, and capital costs of natural uranium–graphite reactors are discussed with specific reference to the EDF3 and EDF4 plants. The prospects for cost reductions are also considered, together with financial and industrial problems associated with nuclear power. (D.C.W.)

38388 (A/CONF.28/P/38) NUCLEAR POWER STATIONS E.D.F.2–E.D.F.3 AND E.D.F.4. C. Bienvenu (France. Electricité de France, Paris), P. Passerieux, and P. Bacher. May 1964. 21p.

The three natural uranium-graphite-CO_2 power stations now being built by Electricité de France are de-

scribed, with emphasis on the evolution of their characteristics and the principal equipment employed. The electrical output has risen from about 200 Mw for EDF 2 to 480 Mw for EDF 3 and EDF 4. The electrical power produced per ton of uranium has increased from 910 kw for EDF 2 to 1170 kw for EDF 3 and EDF 4. Simultaneously, the temperatures of the gases and the cans have risen and efficiencies have increased. EDF 2's metal pressure-vessel, consisting of a sphere about eighteen meters in diameter rated at 28 bars, was replaced in subsequent power stations by pre-stressed concrete structures. To step-up the unit powers of the blowers (from 6 to 15 Mw), turbines instead of electric motors are now used. The fuel loading devices, the heat exchangers, and the burst-slug detection systems have also developed considerably from one power station to the next. EDF 4 is the first "integrated" power station, with its heat exchanger located in the pre-stressed concrete pressure-vessel, beneath the reactor. This new arrangement has called for corresponding new internal layout, and certain equipment had to be adapted. However, the designers have striven to keep the other equipment as similar as possible to that developed for EDF 3, as is the case for the core design, the fuel elements, the loading equipment, and the turbo-generator sets. (auth)

38389 (A/CONF.28/P/39) HEAVY-WATER-MODERATED GAS-COOLED REACTORS. Bernard Bailly Du Bois, Jean-Louis Bernard, Roger Naudet, and Roland Roche (France. Commissariat à l'Energie Atomique, Paris). May 1964. 13p.

France has based its main effort for the production of nuclear energy on natural-uranium, graphite-moderated, gas-cooled reactors, and has a long-term program for fast reactors, but is also engaged in the development of heavy-water-moderated, gas-cooled reactors, which appear to present the best middle-term prospects. The economy of these reactors, as in the case of graphite, arises from the use of natural or very slightly enriched uranium; heavy water can take the best advantages of this fuel cycle and moreover offers considerable development potential because of better reactor performances. The program devoted to the development of the EL 4 type in France is discussed. Reasons for selecting this reactor type are given: advantages and difficulties are underlined. After reviewing the main technological problems and the research and development carried out, results already obtained and points still to be confirmed are reported. The construction of EL 4 is an important step of the program: it will be a significant demonstration of reactor performances and will afford many experimentation opportunities. The design of large power reactors is considered. Extension and improvements of the mechanical structures used for EL 4 are under study, as well as alternative concepts. The paper gives some data for a large reactor in the present state of technology, as a result from optimization studies. Technical improvements, especially in the field of materials could lead to even more interesting performances. Some prospects are mentioned for the long run. Investment costs and fuel cycles are discussed. (auth)

38390 (A/CONF.28/P/40) EL 4—FEATURES AND CONSTRUCTION PROBLEMS. Remy Carle (France. Commissariat a l'Energie Atomique, Paris), Pierre Schulhoff, Philippe Sevin, and Jean Buttin. May 1964. 16p.

EL 4 is the prototype of a new series of reactors moderated with heavy water and cooled by carbon dioxide. It was studied with a double purpose: to realize a sufficiently large and complete reactor for testing the problems of construction and operation of this type of reactors; and to keep in this installation the possibility of adapting the improvements (new materials, improved fuel elements) studied in the research and development program. The first objective could not be considered without a considerable volume of preliminary work. This work included particularly the construction and testing from 1962 to 1964 of several prototype channels, out-of-pile, but under the actual temperature and pressure conditions. These tests showed the proper behavior of the materials under the severe mechanical and chemical conditions of the reactor. These installations will, furthermore, be available for testing further modifications before adapting them to the reactor. Important tests concerning the safety of the reactor in the event of an explosion of the CO_2 circuit were also carried out. Construction itself began in July 1962 under the double direction of the Commissariat à l'Energie Atomique and Electricité de France. The civil engineering work will be finished in 1964. The air-tight containment (in which it was considered preferable to house the reactor because of its prototype character) was built in pre-stressed concrete, a method that appeared to be particularly rapid and easy. The main piece of the reactor is the heavy water tank. This tank is composed of two double end plates equipped with 216 tubes and joined by a steel cylinder. Some difficult welding problems according to the specifications were solved during the construction of these bottoms. A rigorous series of controls by radiographic and ultrasonic methods was adapted to a complicated geometry. The assembly of the reactor unit, and particularly of the array of tubes supplying the 216 channels, was studied in every detail and the connections to be employed were tested. The whole circuit is made in fairly classical materials (slightly alloyed steels) whose behavior in the carbon dioxide at 500°C was proved. Aerodynamic tests were carried out for the helico-centrifugal blowers (of unit power 9 Mw). The choice of a pressure as high as 60 kg/cm^2 does not seem to induce new problems in connection with leaks on the machine shafts. The choice of a type of CO_2–steam heat exchanger with forced circulation led Electricité de France to test the operation and stability of a prototype exchanger in its test plant. The reactor will be equipped with a depressurizing and desuperheating system that will allow the reactor to operate at 20% of its nominal power whether the turbo-alternator is available or not. (auth)

38391 (A/CONF.28/P/43) INTEGRATING NUCLEAR POWER INTO THE FRENCH ELECTRICITY NETWORK. R. Janin (France. Electricite de France, Paris). May 1964. 15p.

Compared to fossil thermal power, nuclear power involves a higher capital cost, at least in its present stage of technical development. Nuclear power stations are therefore only preferable when they can operate for long periods. Study of the possibilities of developing this new form of energy must be based on the load curve of the network. Until now, hydro and thermal power have appreciably shared the task of supplying the French network. Allowing for its limited potential development, hydro power is now expanding at a constant rate, whereas consumption is continuing its exponential increase. The proportion to be supplied by fossil-based and nuclear fuel thermal power will therefore rise. Hydro generating methods will, as far as possible, be more and more directed towards the generation of small amounts of power. Over-equipping of existing power stations will

also contribute towards proper operation of thermal and nuclear station, by supplying peak loads. Since the ratio between the maximum and minimum points on the load diagram is about 2, the possibility of integrating basic nuclear power naturally involves no problem at present. It has been verified that, even with the highest possible expansion that may reasonably be expected for this power, it will not exceed the zone of maximum use during the next twenty years. It is therefore not the requirements of the load curve that are now hindering rapid development of this new source of power, but rather the uncertainty, although less felt today, as regards the physical and economic performance of the new power stations. (auth)

38392 (A/CONF.28/P/44) DIRECT HEAT CONVERSION INTO ELECTRICITY IN REACTORS. Bernard Devin, Jean Bliaux, and Robert Lesueur (France. Commissariat a l'Energie Atomique, Paris). May 1964. 17p.

The direct conversion of heat into electricity by thermoionic emission in an atomic reactor has been studied with the aim of its utilization as an energy source for a space device, at the head of a conventional conversion system in power installations, or in association with the thermoelectric conversion in very-low-power installations. Laboratory experiments were mainly orientated towards the electron extraction of metals and compounds and their behavior at high temperatures. Converters furnishing up to 50 amps at 0.4 volts with an efficiency close to 10% have been constructed in the laboratory; the emitters were heated by electron bombardment and were composed of tungsten covered with a uranium carbide deposit or molybdenum covered with cesium. The main aspects of the coupling between the converter and the reactor have been covered from the point of view of electronics. These include the influence of the mismatching of the load on the temperature of the emitter, and the influence of thermal flux density on the temperature of the emitter and the stability of the converter. Converters using uranium carbide as the electron emitter have been tested in reactors. Tests have been made under dynamic conditions in order to determine the dynamic characteristics. The load matching curves have been constructed and the overall performances of several cells coupled in such a way as to form a reactor rod have been deduced. The problems associated with the reliability of thermionic converters connected in series in the same reactor rod have been examined theoretically. The absorption isothermals have been drawn at the ambient temperatures for krypton and xenon on activated carbon with the aim of investigating the escape of fission products in a converter. (auth)

38393 (A/CONF.28/P/46) ECONOMIC ASPECTS OF ELECTRICITY AND INDUSTRIAL HEAT GENERATING NUCLEAR PLANTS. Jacques Gaussens, Nicolas Moulle, and Françoise Dutheil (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 17p.

The economic advantage of electricity-generating nuclear stations decreases when their size decreases. However, when a counter-pressure turbine is joined on to a reactor and the residual heat can be properly used, it can be shown that fairly low capacity nuclear equipment may compete with conventional equipment under certain realistic enough conditions. These special conditions under which nuclear energy can be profitable are defined. They are connected with the location and the general economic environment of the station, the pattern of the electricity and heat demands it must meet, the level of fuel and specific capital costs, nuclear and conventional. These conditions entail certain technical and economic specifications for the reactors used in this way otherwise they are unlikely to be competitive. In addition, these results are referred to the potential steam and electricity market, and certain uses for the heat generated by double purpose power stations are examined; for example, to supply combined industrial plants, various types of town heating, and for removal of salt from sea water. (auth)

38394 (A/CONF.28/P/52) THE PRESTRESSED CONCRETE PRESSURE VESSELS FOR FRENCH NATURAL URANIUM–GRAPHITE–CO_2 GAS TYPE REACTORS. Georges Lamiral (France. Electricité de France, Paris), Louis Laurent, Robert Bonnelle, Nicolas Beaujoint, and Paul Faurot. May 1964. 21p.

The basic components of the pressure vessels of the reactors of EDF 3 and EDF 4 power stations, built respectively at Chinon and at St-Laurent-des-Eaux. The pressure vessel of EDF 3 power station, designed for an operating pressure of 30 atmospheres, has approximately the shape of a parallelepiped with a square base with sides 25 meters long, and is 32 meters high; its effective capacity is bounded by a cylinder 19 meters in diameter and 21 meters high. The pressure-vessel of EDF 4 power station, which houses the reactor core and the heat exchangers, is designed for an operating pressure of 29 atmospheres; its effective capacity is bounded by a cylinder 19 meters in diameter and about 37 meters high. The design of these structures sets many problems, which can only be overcome after trials on scale models. Since the high temperatures reached by the carbon dioxide gas are today considered incompatible with prestressed concrete, the concrete has to be insulated from the gas and cooled; many tests were carried out, and new solutions were found for these problems. The inclusion of the primary circuit within the reactor pressure vessel meant such huge dimensions that prestressed concrete was the only feasible solution; any development of natural uranium-graphite-carbon dioxide gas type reactors are therefore tied to the development of this technique. (auth)

38395 (A/CONF.28/P/54) REFUELING EQUIPMENT IN NATURAL URANIUM–GRAPHITE–GAS REACTORS. Boris Saitcevsky and Denis Gaussot (France. Electricité de France, Paris). May 1964. 18p.

The refueling system is one of the vital parts of a natural uranium-graphite-gas sequence nuclear power plant. From the costs standpoint, it involves 8 to 10% of total capital expenditure, at the moment. From the technical standpoint, the question is complex, both as regards the tasks the equipment must fulfil and the high safety requirements. The various fundamental aspects of operation and safety are reviewed, enabling principles universally applicable to be brought out. Factors governing the basic choice are analyzed, and the value of actual operation is emphasized. (auth)

38396 (A/CONF.28/P/55) SOME FUNDAMENTAL ASPECTS OF BOILING IN NUCLEAR REACTORS. Henri Mondin, Pierre Lavigne, and Roger Semeria (Commissariat à l'Energie Atomique, Paris). May 1964. 12p.

Boiling mechanisms and related phenomena in nuclear reactors are discussed. (auth)

38397 (A/CONF.28/P/69) CORE STRUCTURES OF THE HEAVY WATER–GAS REACTOR EL 4. Jean L. Bernard, Henri Foulquier, and Paul Thome (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 14p.

The core of this reactor consists of a vessel containing heavy water, through which pass pressure tubes for circulation of the cooling gas under pressure. The basic specifications, which greatly influenced the design of this construction, relate to aspects of safety in operation (fuel loading from both faces of the reactor, replacement of the components on both faces), neutronic demands (minimum absorption of the components lattice parameter, diameter of the pressure tubes), and thermal considerations (output temperature 500°C). These specifications have led to a horizontal arrangement of the pressure tubes and raised very difficult problems of clearance, which make it impossible (for the dimensions of EL-4) to resort to expansion bellows on the pressure tubes. The result is a semi-rigid vessel in which the pressure tubes contribute to a large extent the mechanical resistance of the system by acting as a brace, whence the high stresses on the joints and pressure tubes (and the choice of zirconium alloys). The construction components include the pressure tube, the joints, the thermal insulation, and the liner tube. A brief account is given of the testing methods used and the performances of these various units. The methods proposed prove practicable as a result of research and development on automatic remote control for all the operations which make up the sequences of mounting, demounting, and repairing the construction components. In particular the possibilities opened by up the new techniques of welding tubes from the inside have been extended to other problems connected with the assembling of a reactor. (auth)

38398 (A/CONF.28/P/77) BURNUP PHYSICS. O. Tretiakoff (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 17p.

The evolution of reactivity (during fuel irradiation) in natural or slightly enriched uranium reactors is discussed. The difficulties of performing direct experiments on large amounts of irradiated fuels are reviewed—especially in operating power reactors—and the necessity is underlined for fundamental research in two directions: the change in the composition of the fuels (chains of heavy nuclei, fission products); and the effect of changes in composition on the neutron balance. Before presenting three types of experiments, which were carried out, the importance of the problems associated with the neutron spectra is stressed and the practical methods used for the calculations are described. The systematic irradiation of several types of fuel, followed by their chemical and isotopic analysis has been going on for several years. An outline of the experimental program is given with a description of the methods employed: α, β, γ chain for the preparation of samples, determination of the plutonium content by coulometry and double isotopic silution, and separation of boron used in some cases for the measurement of integrated neutron densities. The interpretation of the measurements is discussed with some examples. A second and more recent series of experiments deals with the investigation of lattices, using "synthetic" fuels (uranium–plutonium alloys) as compared to slightly depleted or enriched uranium. Various experiments are considered on heavy water and on cold graphite, then on graphite heated up to 500°C. Some results already obtained are listed. These experiments, requiring nearly a metric ton of each type of fuel cannot be pursued in a systematic manner. This is why it is developed since several years a method of differential measurement by oscillation, which requires samples of the order of several kilograms only. The relations between these measurements and the investigations of lattices are discussed, and an outline is given of the way of carrying out the systematic study of fuels of various compositions. The method was successfully applied to the systematic study of irradiated fuels (analyzed independently by the methods mentioned above) thus giving the possibility of measuring "in situ" the absorption of fission products. (auth)

38399 (A/CONF.28/P/79) PREDICTED DYNAMIC BEHAVIOUR OF RAPSODIE. René Abdon and Michel Chaigne (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 17p.

Computer studies were made of the behavior of the Rapsodie reactor with oxide fuel. The studies covered accidents with and without the safety system, reactor operation, and stability. The results show that in case of accident, no damage will affect the plant even if the safety fails, and that the reactor is fully stable. The design of a training simulator is described briefly. (D.L.C.)

38400 (A/CONF.28/P/80) SOME SPECIAL ASPECTS OF CONTROL IN NUCLEAR POWER REACTORS. Jacques Furet (France. Commissariat à l'Énergie Atomique, Paris) and Jean Pupponi. May 1964. 15p.

There are still many problems in the field of measurement and control of neutron flux. The present studies in connexion with high flux reactors contribute to the solution of these problems which concern specialists in reactor control. The present state of this investigation and the results of different studies carried out in France by the C.E.A. and the E.D.F. are pointed out: a) In the nuclear ihstrumentation field, work is at present devoted to the technologies used to develop detectors and cables, which have to work at high temperature and in a high γ background; fast electronic techniques are applied to fission counters to measure low neutron fluxes in a high γ background (10^6 r/hr). b) In the control and safety field, there is a real need for studies on the behavior of reactors in the subcritical state. This increases the margin of security during restarts when poison effects must be overcome. The perturbations due to control rod movements necessitate a new organisation of power level safety and control assemblies, in connexion with thermal or activation measurements. Two methods of fast start-up are described. They are related to the fission rate measurement as a function of time. This is done either continuously by a constant and high reactivity change, or step by step. The application of automatic techniques to detector motion seems to give the answer to control and safety in normal start-up. c) The methods used for the control of EDF 3, are described. (auth)

38401 (A/CONF.28/P/81) SAFETY OF NATURAL URANIUM–GRAPHITE GAS-TYPE REACTORS. R. Fays (France. Electricité de France, Paris); L. Laurent, F. de Vathaire, J. Plisson, and J. Bussi. May 1964. 15p.

Safety considerations involved in the development of graphite-gas reactors in France are reviewed. These considerations include design and construction, and operation of the reactors. The principal incidents liable to occur are reviewed, and the steps taken to minimize their consequences are examined. (D.L.C.)

38402 (A/CONF.28/P/94) CO_2 CIRCUITS IN NUCLEAR POWER STATIONS. [Etienne] Robert, [J.] Hustache, and [P.] Sevin (France. Electricité de France, Paris). May 1964. 18p.

A description is presented of the major components (i.e., heat exchangers, blowers, and expansion and isolating equipment) in the CO_2 coolant systems of the EDF 1, 2, 3, and 4 reactors. (T.F.H.)

38403 (A/CONF.28/P/96) IMPROVEMENTS MADE TO THE THERMAL TRANSFER OF FUEL ELEMENTS BY

USING THE VAPOTRON PROCESS. Jean-Daniel Le Franc (Compagnie Francaise Thomson-Houston, Paris), Hans Bruchner, Paul Domenjoud, and Rene Morin. May 1964. 19p.

The application of the Vapotron process to boiling water reactors is considered. The principle of the Vapotron effect, adaptation problems, tests on elementary corrugations, tests on Vapotron sheets, and neutron loss are discussed. (C.E.S.)

38404 (A/CONF.28/P/99) THE ESSENTIAL FACTORS IN A BALANCED NUCLEAR ECONOMY. THERMAL AND BREEDER REACTORS. R. Gibrat (Indatom, Paris). May 1964. 12p.

Losses of fissile materials, immobilization in pile inventories, and reprocessing and manufacturing delays for breeder reactors are discussed. Equations corresponding to these problems are given, their dependence on the growth rate of the total nuclear economy is established, and the degrees of participation of breeders are calculated. (R.E.U.)

38405 (A/CONF.28/P/121) THE DRAGON PROJECT. C. A. Rennie, G. E. Lockett, and R. E. Reynolds (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). May 1964. 15p.

The Dragon Project is a joint undertaking between twelve European countries to carry out a program of work in the field of graphite moderated, helium cooled, high temperature reactors. The history of the Project is described. The Project's tasks, and the organization and policies adopted for the execution of those tasks, are summarized, and a report of the present state of the Project's work is given. The international aspects of the Project are examined and their effect upon the working of the Project is discussed. The relative advantages and disadvantages of the Project's form of organization are reviewed. A summary is given of the aims and objects of the program of research and development work carried out in the Project. This work was initially directed to providing answers to specific problems which arose during the design phase of the reactor experiment but was extended, wherever possible, to cover the more general problems arising in high temperature reactors. One very important aspect of the Project's research and development work was, and is, the study of fuel elements for these reactors. A description is given of the reactor experiment being built at Winfrith with particular emphasis on the features of this reactor experiment which should help in solving the problems of future high temperature reactors. An account is given of the work which the Project has done on large high temperature reactors. The assumptions on which the work is based are outlined, and the steps being taken to prove or disprove these assumptions are discussed. (auth)

38406 (A/CONF.28/P/122) REVIEW OF RESEARCH AND DEVELOPMENT WORK FOR THE DRAGON PROJECT. L. R. Shepherd (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England), H. de Bruijn, R. A. U. Huddle, and K. O. Hintermann. May 1964. 15p.

The uranium-thorium cycle in a large power reactor with carbon moderator is described briefly. In the Dragon reactor experiment, the core is small and it was found desirable to employ two types of fuel arranged in two zones. One type consists of uranium-235, thorium-232, and carbon, in proportions that might be typical of the composition in a large power reactor: The other type of fuel contains uranium-235 and zirconium as monocarbides, and makes up about three quarters of the core. The main reactor physics features of this core arrangement are described. The adoption of the purged fuel element in the Dragon reactor experiment has necessitated the development of special graphites. The problems of obtaining the right physical characteristics in these graphites and the production difficulties are reviewed briefly. Although helium is used as a coolant, the presence of oxidizing impurities leads to corrosion and mass transfer of the exposed graphite surfaces. The investigation of this phenomenon was carried out in laboratory-scale experiments and also with out-of-pile and in-pile loops. A complementary program of work on the purification of helium to remove the chemical impurities and entrained fission products was also carried out on the laboratory scale and in a pilot plant. The diffusion of fission products and their evolution from graphite/carbide fuels at high temperatures is one of the major problems in reactors of this type. A solution to the problem was sought in the use of pyrocarbon and silicon carbide coated particles. Results of irradiation experiments with a variety of specimens of uranium/zirconium monocarbide and uranium/thorium dicarbide coated particle fuels are reviewed. The production of coated particle fuel and its assembly into the Dragon reactor experiment fuel element is being carried out by the Project on the reactor site. An outline of the production procedure is given. (auth)

38407 (A/CONF.28/P/124) THE TREND TO HIGHER RATINGS IN THE MAGNOX REACTOR. D. R. Smith, P. D. Murphy, R. Rutherford, C. S. Lowthian, and J. M. Yellowlees (Nuclear Power Group, Knutsford, Ches., England). May 1964. 16p.

The specific rating of a reactor directly affects the size of core, pressure vessel, biological shield, and site layout. These items are relatively expensive in magnox stations, and hence there exists an incentive to go to higher ratings. The specific reactor rating depends almost entirely on fuel rating and Vm/Vu. Physics imposes tight limits on Vm/Vu; hence increased specific rating means in practice increased fuel rating. Fuel rating is limited by: endurance of fuel element and reactor core, fuel handling (blow-out), and safety. With solid uranium metal rods the mean fuel rating cannot be increased economically above about 1 Mw(e)/Te. For higher ratings it is necessary to employ alternative fuel geometries having thinner sections and an enhanced surface heat transfer capability; for example a cluster of solid rods, tubular element, or a rectangular bar. In an economic comparison of these geometries the important characteristics are fuel fabrication cost and maximum permissible fuel rating. The former is influenced by the complexity of the assembly and the weight of uranium per assembly. The limiting fuel rating may be set by temperature limits, available reactivity, or heat transfer performance. The technical problems and economic trends of alternative fuel geometries within these limitations are discussed. (auth)

38408 (A/CONF.28/P/125) THE CONTRIBUTION OF THE WINDSCALE ADVANCED GAS COOLED REACTOR TO THE DEVELOPMENT OF A COMMERCIAL POWER SYSTEM. K. Saddington (United Kingdom Atomic Energy Authority. Reactor Group, Windscale, Cumb., England), T. N. Marsham, and J. Moore. May 1964. 15p.

Operational experience with the WAGR is reviewed in the light of its application to the design and operation of a commercial reactor. The problem of planning reactor loading patterns and fuel cycles, and experience with the computer programs used for the WAGR and presently being developed for commercial AGR cores are discussed. The utilization of the reactor and independent loop circuits for experimental purposes is described. (auth)

38409 (A/CONF.28/P/126) RECENT DEVELOPMENTS IN THE INSTRUMENTATION AND CONTROL OF LARGE GAS-COOLED REACTORS. D. S. Hiorns (Gt. Brit. Central Electricity Generating Board, London), T. O. Jeffries, D. Moore, H. Moores, and A. H. Weaving. May 1964. 15p.

Since the design of the first British gas-cooled power reactors some 5–7 years ago, work has proceeded to simplify operational control and improve reliability. Three aspects of this are discussed, improvements to main control displays, and the application of solid state techniques to safety circuits and to control rod supplies. The application of large data processing units, now available in a proved and reliable form has facilitated increased centralization of the control function. The information from the plant amounting to perhaps 7,000 readings on a two reactor station is processed and only the information required by the operators is displayed. The use of cathode ray tubes on which alpha-numeric information can be reproduced, provides the necessary flexibility for this application. Corresponding improvements are also described for the panels housing the controls. Until recently, all the British civil nuclear power reactors employed electromagnetic relays in the protection systems. To improve the inherent safety of a protection system, and reduce maintenance testing to a minimum, the application of solid state switching devices was studied and the Laddic was found to fulfil safety requirements. The Laddic is a multiaperture ferrite core, upon which logic may be performed and its development for this purpose is described together with its application to a reactor protection system. Low frequency supplies in the range 0-1 cycle, are provided to operate the control rod actuator in power reactors. This arrangement obviates the need for clutches and high ratio gear trains within the reactor. The low frequency supplies, derived in the early reactors from rotating plant, are now derived from static generating equipment employing magnetic amplifiers or thyristors, which modulate the output of the equipment to give the low frequency required. To guard against the lack of inertia in a static generating system features are incorporated to maintain the low frequency supplies during transient disturbances on the main supply, thus enhancing reactor availability. (auth)

38410 (A/CONF.28/P/127) DEVELOPMENT OF COMMISSIONING PROCEDURES FOR GAS COOLED REACTORS. E. Anderson and E. Stephenson (Nuclear Power Group, Knutsford, Ches., England). May 1964. 15p.

The planned and actual commissioning program for Bradwell and Latina are compared, and it is shown that the experience with the earlier stations enabled substantial reductions to be made in the time taken to commission Latina. In the mechanical proving tests, the major savings were in leak testing and rectification, in the testing of the fuel handling equipment, in the removal of protective coatings, and in the final proving runs. A considerable part of the commissioning phase is occupied in loading fuel and in setting the gags controlling the flow of coolant gas in each fuel channel or in measuring this flow. Improved methods and organization enabled the times for these operations to be substantially reduced, and an outline of these methods is included. (auth)

38411 (A/CONF.28/P/128) EARLY OPERATION OF THE C.E.G.B. NUCLEAR POWER STATIONS. D. R. R. Fair and R. L. Rutter (Gt. Brit. Central Electricity Generating Board, London). May 1964. 15p.

The objectives before the C.E.G.B. operators when generation commenced in June 1962 are outlined. It records in tabular form the performance of Berkeley and Bradwell during the peak loading of the C.E.G.B. system in the first winter of operation, November 1962/February 1963. An analysis is made of the station utilization from start-up to December 1963, and the limitations of output and availability are recorded and discussed. The reliability of nuclear generation following a careful period of commissioning is made clear. The operating costs, fuel, fuel handling, and other operational and maintenance costs for both Berkeley and Bradwell are discussed, and the very high incentive to maintain the nuclear stations at full power for the maximum time is illustrated. The replacement fuel costs for Bradwell within the C.E.G.B. system for different times of the year are reported. There is discussion of the overall initial performance, and comparisons are made between nuclear and non-nuclear effects. Two of the nuclear limitations to performance are discussed in some detail; the case for a higher permissible fuel element temperature than that adopted at start-up and the case for a higher permitted graphite temperature. The case for the higher permissible fuel element temperature discusses the magnox ignition temperature and records the acceptance of 645°C for this purpose in dry carbon dioxide. The results of reassessments made of the transient rise in temperature in the reactor during certain postulated fault conditions, are presented. The case for the higher permissible graphite temperature involved consideration of the chemical reactivity of the graphite from which the graphite cores at Berkeley and Bradwell were constructed and an analysis of the results of sample measurements. The approach to the interpretation of air reactivity of graphite therefore emphasised two points. The first was that the value of graphite air reactivity should properly be associated with a given volume and probability, and the second was that more experimental information on the distribution of reactivity within graphite bricks was needed. A summary is made of the main arguments leading to the acceptance of both cases by the C.E.G.B. Nuclear Power Station Safety Committee and by the U. K. Inspectorate of Nuclear Installations. Certain operational procedures are reviewed, and the internal inspection of reactors and the case for the internal inspection of the nuclear boilers are discussed. New techniques for the former are described and new judgments concerning the latter are suggested. (auth)

38412 (A/CONF.28/P/129) GENERAL DESIGN OF THE STEAM-GENERATING HEAVY WATER REACTOR. S. Fawcett (United Kingdom Atomic Energy Authority. Reactor Group, Risley, Lancs, England), A. Firth, and J. E. R. Holmes. May 1964. 16p.

The 100 Mw(e) SGHWR prototype evolved from the steam cooled heavy-water reactor. Design features result in low capital costs due to low heavy water inventory and a direct steam cycle. Fuel costs are low due to good neutron economy. On-load refuelling and superheat is possible and large size units can be built without introducing new feasibility problems. The fuel rods are of full core length and cluster spacing is obtained either by grids or by helical wire wrapping. The core comprises 112 Zircaloy pressure tubes (including 8 superheat channels) passing through an aluminum alloy calandria. Light water recirculates through the boiling channels, giving 13% exit steam quality by weight. Reactor power is controlled by moderator level, with moderator poison for long term reactivity changes and absorber fluid tubes for rapid shut down and possibly for flux trimming. (auth)

38413 (A/CONF.28/P/130) PERFORMANCE AND OPERATION OF THE DOUNREAY FAST REACTOR. R. R.

Matthews, J. L. Phillips, K. J. Henry, R. H. Allardice, D. M. Donaldson, and H. E. Tilbe (United Kingdom Atomic Energy Authority. Industrial Group. Dounreay Experimental Reactor Establishment, Caithness, Scotland). May 1964. 15p.

The original metallic fuel concept was retained and following redesign of the element as a result of experience on irradiation behavior, the limiting burn-up of the fuel was raised to over 1% of heavy atoms. The redesigned element permitted the reactor power to be raised to the design figure of 60 Mw. Having demonstrated the feasibility of operating fast reactors at power, the reactor was converted into a fast flux irradiation test facility. Modifications to the reactor circuits were made to increase the capacity of the cold trapping system and new in-line purity measuring devices were developed. Other additions were a corrosion sampling device which is operable at full circuit pressure and a corrosion measuring device in one of the by-pass circuits. A description is given of the major steps in starting up, control, and shutting down the reactor. The kinetic behavior of the reactor was studied and generally is in agreement with prediction. Experience was gained on the control of the fission product activity both during normal operation and during maintenance operations. The chemistry of the coolant was studied. The chemical reprocessing plant has now commenced operation with highly irradiated fuel. (auth)

38414 (A/CONF.28/P/131) THE INITIATION OF A NATIONAL NUCLEAR POWER PROGRAMME. G. F. Kennedy and R. F. W. Guard (Kennedy and Donkin, Consulting Engineers, London). May 1964. 16p.

The problems faced by a country about to install its first nuclear power station are discussed, assuming the reactor will come from a foreign supplier. Administration, construction, and contract negotiations are considered, as well as selection of the reactor size, fuel cycle, type, and site. (D.C.W.)

38415 (A/CONF.28/P/137) GRAPHITE CORE STRUCTURES FOR LARGE GAS-COOLED POWER REACTORS. P. C. Warner and M. A. Bayer (United Power Co. Ltd., London). May 1964. 15p.

The design techniques by which reasonable channel alignment is maintained and gas by-pass of the fuel channels is prevented are discussed, with specific reference to the development and features of the Hunterston, Trawsfynydd, and Tokai Mura designs. A core design for a 500-Mwe unit is outlined. (D.C.W.)

38416 (A/CONF.28/P/141) THE DESIGN OF PRESTRESSED CONCRETE PRESSURE VESSELS, WITH PARTICULAR REFERENCE TO WYLFA. R. S. Taylor (Taylor Woodrow, Ltd., Whetstone, Leics, England) and A. J. Williams. May 1964. 15p.

The evolution of prestressed concrete pressure vessels for gas-cooled graphite-moderated nuclear reactors is described with particular reference to the twin reactor vessels under construction at Wylfa Nuclear Power Station. A brief review of the characteristics and limitations of steel systems is followed by a statement of the main advantages of prestressed concrete vessels. The suitability of such vessels for integrated reactor systems and the resulting enhanced safety characteristics and flexibility of reactor design are discussed. The manner in which the design of the vessel is influenced by that of the reactor is described. The optimization of a nuclear power station incorporating prestressed concrete pressure vessels is considered, together with the problems associated with penetrations, radiation effects, containment of system pressure, and control of vessel temperature. A review is made of the various design concepts of prestressed concrete pressure vessels studied prior to the adoption of the Wylfa design. The advantages and limitations of each are stated, and specific quantities compared. (auth)

38417 (A/CONF.28/P/142) THE DEVELOPMENT OF BURST CARTRIDGE DETECTION SYSTEMS WITH PARTICULAR REFERENCE TO SIZEWELL NUCLEAR POWER STATION. B. Holmes and A. D. Boothroyd (English Electric Co., Ltd., Whetstone, Leics, England). May 1964. 15p.

Operation of the Calder Hall and Chapel Cross reactors has shown that burst cartridge detection systems must be designed to detect and locate fast and rapid bursts and cavitation failures. The necessity for rapid detection of fast bursts lays emphasis on frequency of scan at the expense of sensitivity. On the other hand, the need to locate channels containing cavitation failures, which contribute to a slow rise in background count, requires the ability to scan the reactor at high sensitivity. For recent reactors a dual scanning system was adopted. In this a rapid scan of groups of up to 32 channels provides the routine operational protection and a slow, periodic, scan of individual channels provides a long term record for every channel from which an increasing count can be determined. In the case of Sizewell the group system is made continuous although the output of the precipitator is presented as a count integrated over a period of about one minute. This reduces the time taken to confirm the existence of a burst and eliminates the need for a selector system, thereby improving reliability of operation. The reactor refueling equipment at Sizewell, differs from earlier stations in that charge chutes remain permanently installed in the reactor and guide tubes above the core bring the channel outlets to a configuration suitable for a simple chute. This arrangement enables removable selector valves to be installed adjacent to the sampling points. These manifold the group samples and operate as selectors for single channel sampling. The group monitor is provided with high count alarms and only following receipt of such an alarm are the integrator outputs recorded. Data from a single channel scan are recorded on punched cards for subsequent analysis by computer. When the system is being used for burst location, the counts are immediately available to the reactor engineer. Facilities for locking on to particular channels are provided on the basis of 1 facility for every 1000 fuel channels. A bulk gas monitoring system is also provided to back up the other systems, particularly when any channel is not being monitored by a system with alarms. Advantage was taken of the existence of a multi-cell precipitation unit developed for the Windscale A.G.R. The performance of the group system was dictated largely by this unit and by the need to keep sample flows small in view of the very large number of samples being taken simultaneously. The principal items of equipment developed specifically for the Sizewell reactors were the primary and secondary selector valves. The former were required to operate in reactor hot gas conditions with considerable reliability and a minimum of two years between maintenance periods. The secondary valve was developed from the primary valve but is subject to less arduous conditions. A development of the Sizewell system includes a thermocouple in the primary selector valve enabling the outlet gas temperature of every channel to be measured. (auth)

38418 (A/CONF.28/P/143) SOME ENGINEERING PROBLEMS OF THE S.G.H.W. 100-Mw(E) PROTOTYPE REACTOR. N. Bradley (United Kingdom Atomic Energy

Authority. Reactor Group, Risley, Lancs, England), P. J. Cameron, and N. J. G. Worley. May 1964. 15p.

Some of the more novel engineering features of the SGHW reactor are described. The problem of joining the zirconium pressure tubes to the steel primary circuit was investigated and two types of mechanical joints, i.e., rolled and bolted, were developed and tested. Dual moderation leads to a tight pressure tube lattice pitch and the engineering solution adopted is described. The results of temperature distribution tests in the bulk moderator are given. Superheat channels are provided to demonstrate safety. In these channels, gamma heat generated in the zirconium pressure tube is removed by circulating boiling water through an internal annulus, operating in parallel with the main boiling channels. A thin stainless steel liner prevents convective heat transfer from the superheated steam to the annulus. Experimental loop facilities are described, these being provided for one cluster fuel element under boiling water conditions associated with a carbon steel circuit, and two pencil fuel element channels associated with a stainless steel circuit. Provision is made to discharge coolant from one superheat channel to the condenser when testing an advanced or intentionally defected superheat fuel cluster. Refueling during operation presents a number of design problems. Test work leading to solutions for the main problems is outlined. The parameters affecting primary circulating pump run-down time and the means by which the required inertia can be built into the system are outlined. The reasons for choosing a wet winding glandless circulating pump are given. (auth)

38419 (A/CONF.28/P/150) DEVELOPMENT AND PERFORMANCE OF DOUNREAY FAST REACTOR METAL FUEL. S. A. Cottrell, E. Edmonds, P. Higginson, and W. Oldfield (United Kingdom Atomic Energy Authority. Industrial Group. Dounreay Experimental Reactor Establishment, Caithness, Scotland). May 1964. 15p.

The original target for fuel elements in the Dounreay Fast Reactor was to enable operation at 60 Mw and to achieve 1.2% burn-up (heavy atoms). Following modifications to the design of the element this target has been reached. The metallic fuel used is an alloy of enriched uranium with 20% molybdenum in an annular form. The fuel is niobium canned. The space between the fuel and can is filled with Na and is deliberately vented to the reactor coolant, NaK. The real fuel irradiation experience was gained from a series of reactor runs at around 30 Mw and from the 60 Mw runs. The earlier design of fuel element was taken to a maximum of 0.6% burn-up. Progressive cracking of the fuel occurred from 0.3% burn-up onwards. Volume swelling of the fuel, however, was as predicted from M.T.R. results. The modification to the element design allowed for 8% diametral swelling within the can. These elements achieved 1.2% burn-up and despite fuel cracking remained externally unchanged. Corrosion of the niobium can by oxygen in the reactor coolant has been investigated. The results indicate that the can temperature must be limited to 480°C to avoid corrosion. A few elements exhibited poor bond flow and fission gas agglomeration. This caused local overheating on the outer surface of some fuel pieces, and in a few instances evidence of surface melting was detected. This phenomenon did not affect the canning of the elements. (auth)

38420 (A/CONF.28/P/159a) FUEL CYCLE COSTS FOR A LARGE NUCLEAR POWER PROGRAMME. FUEL CYCLE COSTS FOR MAGNOX, A.G.R., AND S.G.H.W. REACTORS. N. L. Franklin (United Kingdom Atomic Energy Authority. Production Group, Risley, Lancs, England). C. Allday, J. L. Gilliams, and D. G. Avery. May 1964. 20p.

The fuel cycle costs of Magnox, A.G.R., and S.G.H.W. are discussed and compared; both average values expected for the first ten years of the installation of any one reactor type, and the long term trends that are anticipated. Effects of possible variations in uranium ore and enrichment prices are demonstrated, together with the cost reductions that can arise from improved fuel management policies and irradiation limits. Design trends leading to lower costs in the long term are identified. U.K.A.E.A. work on the physics of plutonium utilization in these systems has shown that it should be possible to introduce plutonium-based fuel into both the A.G.R. and S.G.H.W. systems without major changes in reactor design. The economics of the use of plutonium in this way is discussed and the relation between Pu values in these systems and in a fast reactor discussed and illustrated. (auth)

38421 (A/CONF.28/P/170) EXPERIMENTAL BASIS OF POWER REACTOR OPERATION. H. A. Hughes (United Kingdom Atomic Energy Authority. Production Group, Windscale, Sellafield, England), D. A. L. Clinch, R. M. Horsley, D. J. Millard, and R. Razzell. May 1964. 13p.

Current methods for obtaining essential operational data on power reactors are almost entirely empirical or semi-empirical in nature because of the present inadequacies of purely theoretical methods of physics calculation. Consequently it has been necessary on the first U. K. civil power reactors at Bradwell and Berkeley to repeat many of the measurements performed on the U.K.A.E.A. reactors at Calder and Chapelcross. The main purpose of all the measurements is to provide data which can be used to define the method of operation which achieves the highest efficiency and output consistent with the assurance that the reactor can be controlled and shut down in all credible fault conditions without the safety margin on any component being exceeded. The paper is mainly confined to a discussion of parameters which determine the net reactivity of these reactors, and to the relevance of kinetic experiments. The assessment of control rod calibration as a function of irradiation and temperature provides a scale for measuring other reactivity parameters, such as the change in reactivity due to the formation of plutonium and fission products, the total temperature poisoning arising from fuel and moderator temperature coefficients of reactivity and reactivity taken up by absorbers. A comparison of the results with theoretical calculations leads to an assessment of the error in applying such methods to the prediction of operational data concerning such problems as fuel cycles and shut-down capacity. In general it is shown that the combination of experiment and theory can satisfy operational requirements within the necessary limits. Kinetic experiments are described which have satisfied four main objectives: to confirm the validity of theoretical models used to calculate the consequences of certain credible fault conditions, from which operational limits on such parameters as fuel element temperature and shut-down capacity under fault conditions can be defined; to measure the response of reactors to small perturbations likely to arise in practice; to confirm the model used for stability studies; to calibrate control rods. (auth)

38422 (A/CONF.28/P/171) EXPERIENCE IN RELATING THE OBSERVED THERMAL PERFORMANCE OF CIVIL MAGNOX–URANIUM POWER REACTORS TO DESIGN PREDICTIONS AND OPERATING CRITERIA. P. R.J. French (Nuclear Power Group, Knutsford, Ches., England),

D. J. Millard, M. J. Cartmell, and B. K. Cesterton. May 1964. 15p.

Experience gained from the operation of the nuclear power stations at Berkeley, Bradwell, and Latina is described, and the relationships between the power output of the reactors, the distributions over the reactor core of gas temperature and fuel element temperature, and the temperature limitations adopted in design and operation are dealt with. The derivation of the temperature limitations that governed the initial design of the reactors is outlined, and the instrumental facilities that are available for checking that these limitations are met during operation are summarized. It is shown that the measurements of fuel element temperature and fuel-channel gas outlet temperature are made on the basis of sampling the actual distributions over the very large numbers of elements and channels. During the early operation of the stations, the gas outlet temperature and the power output were restricted by criteria based on the predicted behavior of the reactors under fault conditions. The derivation of these criteria, and of a rapid approximate method of temperature assessment which enabled the fault criteria to be translated into simple operating rules concerning the maximum permitted values of the indicated gas and fuel element temperatures, is explained. Technical progress has since enabled the operating restrictions to be relaxed, thus enabling all the stations to be operated at design output or above. A description is given of a method of analyzing the operational temperature measurements, which has been programmed for a digital computer, and has been found to be convenient and effective in practice. The method yields print-outs in the form of core plans showing the inferred systematic distributions, channel by channel, of fuel element temperature and channel gas outlet temperature, under both steady-state and fault transient conditions. The analysis also determines the standard deviations of fuel element temperature and gas temperature, so that estimates of the random maximum temperatures under normal and fault conditions can be made. Methods available for the prediction of temperature distributions for given operating conditions are outlined, and predictions made by these methods are compared with observations at the three stations. A table is included to show the comparison between the design power output and temperatures, the conditions existing during early operation, and more recent conditions at all the stations. (auth)

38423 (A/CONF.28/P/173) THE PHYSICS OF THE DOUNREAY FAST REACTOR AT POWER. D. C. G. Smith, K. W. Brindley, D. Tait, and R. C. Wheeler (United Kingdom Atomic Energy Authority. Industrial Group. Dounreay Experimental Reactor Establishment, Caithness, Scotland). May 1964. 15p.

The physics of the Dounreay Fast Reactor are studied at power, to the end of 1963. (auth)

38424 (A/CONF.28/P/174) REACTOR PHYSICS STUDIES FOR STEAM GENERATING HEAVY WATER REACTORS. C. G. Campbell, D. Hicks, I. Johnstone, and D. C. Leslie (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Establishment, Winfrith, Dorset, England). May 1964. 15p.

The special reactor physics problems arising from the use of a boiling steam-water mixture as the coolant in a pressure-tube, heavy-water-moderated reactor are discussed, with particular reference to the SGHW prototype reactor under construction at Winfrith. This reactor concept has led to the development of the 5 neutron-group METHUSELAH code for the assessment of core performance for design purposes, and to the THULE scheme of reactor physics calculation. The phase of the experimental work described concerns the detailed study of the neutron balance in a range of lattices of the pressure tube heavy water type. The work has concentrated on the study of the void coefficient of reactivity and has required the simulation of light water coolant over a range of densities in unpressurized assemblies. Experimental techniques for characterizing events in the fast, resonance, and thermal neutron energy regions are described. The high accuracy demanded of these techniques is fixed by the requirement that the void coefficient, which is a differential effect, shall be measured with acceptable accuracy. In addition to these detailed lattice cell measurements, a range of buckling measurements in lattices with and without light water coolant has been used to provide a check on the void coefficient of reactivity and of the effects of leakage on the neutron balance. The use of two subcritical assemblies and of the Dimple critical reactor for these studies is described. Particular attention has been given to the comparisons of experimental results with the THULE and METHUSELAH predictions. A method for inferring errors in the theoretical predictions, by deducing a value of the infinite multiplication constant from the detailed lattice cell measurements, is presented. Detailed comparisons of the experimental results from the range of lattices with the THULE and METHUSELAH predictions are given, with comments on the accuracy of these methods of calculation for detailed design and reactor assessment purposes. (auth)

38425 (A/CONF.28/P/175) BRADWELL NUCLEAR POWER STATION—COMPARISON OF SHIELDING PERFORMANCE WITH DESIGN CALCULATIONS. F. P. Youell (Nuclear Power Group, Knutsford, Ches., England), A. K. McCracken, and P. Oliver. May 1964. 15p.

The results of radiation measurements through the shields of the Bradwell reactors are used to test methods of calculation used in power reactor shield design. The methods used, based on a combination of removal and age-diffusion theory, have been tested using slab shields of simple configuration. However, to treat the effects of complex geometry found in the shields of large power reactors, various extensions to these methods of calculation are necessary and an attempt is made to test the modified methods by comparing the results of calculation with experimental measurements. Measurements of thermal neutron reaction rates were made using manganese-nickel alloy foils. Fast neutron reaction rates were measured with pellets and blocks of sulfur, and gamma dose rates with condenser ion chambers. The modified methods of calculation for the side and top bradwell shields are described in detail, particular attention being paid to the treatment of shield layers which do not approximate to uniform slabs of material. The measured and calculated reaction rates agree to within a factor of 2, over attenuations of 7 or 8 decades. Thus it is shown that the methods of calculation developed for systems with simple geometry may be extended so as to apply to the complex shield configuration of large power reactors. (auth)

38426 (A/CONF.28/P/177) A STUDY OF FUEL CYCLES AND FUEL CYCLE PROBLEMS FOR ADVANCED GAS COOLED GRAPHITE MODERATED REACTORS. B. Cutts (United Kingdom Atomic Energy Authority. Reactor Group, Risley, Lancs, England). May 1964. 15p.

The British advanced gas-cooled graphite-moderated

reactors will have facilities for fuel replacement on-load. The advantage of this facility, apart from the maintenance of a high load factor, is that the average core properties in each region of the reactor may be maintained sensibly constant, since the addition of new fuel is counterbalanced by the removal of fully burnt fuel and the changes in fuel properties generally with irradiation. Because the average properties of each region of the reactor are maintained constant the macroscopic flux and power distributions will also remain unchanged during irradiation though the power generated by each piece of fuel (and therefore each channel) will vary as burnup proceeds. As fuel is irradiated the reactivity it is able to provide in the reactor decreases because of the general burn-out of the fissile elements, the accumulation of fission product poisons and the formation of ^{240}Pu and ^{242}Pu. However, because each region contains fuel at all irradiation levels it is possible to balance the excess neutron production of fresh fuel against the deficiencies of fuel that is almost fully burnt-up. The feed enrichments are therefore reduced well below what would be required if the reactor operated as a whole batch, and of course the average irradiation of the fuel approaches closely the maximum that the fuel can stand from an endurance point of view. The feed enrichments for a reference design of Advanced Gas-Cooled Reactor are given. The properties of the reactor in the equilibrium condition are easily established. However, disturbances from this condition will always exist because it will be necessary to change the reactor from a fresh-fueled state at the start of life to the equilibrium state. This process will take several years. Furthermore improvements in fuel endurance during reactor life and changes in the cost of fissile materials call for a change in the target irradiation or even of the fissile elements used. The effects of such changes on the fuel utilization and on the ratio of peak to average channel power output need to be known at an early stage, since they have some influence on the design of the reactor. (auth)

38427 (A/CONF.28/P/178) TEMPERATURE LIMITS AND THE OPTIMIZATION OF POWER OUTPUT IN CALDER AND CHAPELCROSS REACTORS. H. A. Hughes, D. S. Briggs, R. Dodds, and R. M. Horsley (United Kingdom Atomic Energy Authority. Production Group, Windscale, Sellafield, England). May 1964. 16p.

The calculations and assessment of experimental data which enable the uncertainty of prediction of the complete steady-state temperature distribution to be determined, the calculation of transient rises suffered by each channel, and the application of these calculations and other data to the determination of operating limits are described. Limitations on the extent of irradiation damage to graphite, phenomena which are also temperature-dependent, can be defined from both operational and safety considerations. The main properties discussed are growth, stored energy, and air-oxidation, the first two being limited by a minimum graphite temperature and the third by a maximum temperature. Growth is monitored by changes in Wigner gap size, the measurements being correlated with dimensional changes produced by irradiating specimens in high flux reactors after correcting the latter results for differences in temperature and dose-rate. A limiting temperature is then set by the criterion that no operational difficulties should arise during the life of the reactor. Stored energy limits are dictated by the criterion that a single channel fire should not spread to other channels. Oxidation of graphite introduces a further heat source into a depressurization fault when air has been drawn into the reactor, and a maximum temperature is set which takes into account the operative measures which it is reasonable to suppose can be carried out if such an incident occurs. The temperature limits on the pressure vessel are fixed by necessity to avoid the occurrence of two main phenomena. The first, which governs the minimum temperature, is brittle fracture, and is studied by out-of-pile and in-pile specimen measurements. The second phenomenon is stress rupture, which sets on upper temperature limit so that the time to rupture at the stress levels obtained in the vessel, making due allowance for relaxation owing to creep, will exceed the required life. The results of analysis of stress rupture data from specimens, and the application of this to the particular conditions, are described. (auth)

38428 (A/CONF.28/P/179) CONTROL, STABILITY AND PROTECTION OF A GAS-COOLED, GRAPHITE-MODERATED REACTOR. J. Brown, A. B. Whiteley, and M. J. Whitmarsh-Everise (Gt. Brit. Central Electricity Generating Board, London). May 1964. 16p.

The control, flux stability, and protection against reactivity faults in large CO_2-cooled, graphite-moderated reactors of the type now in operation or under construction in Great Britain are studied. The steady state design limitations are stated, derived from limits set by fault criteria in relation to fuel element properties. The difficulties of correctly flattening the radial flux shape of such a reactor are discussed, with examples. The assumptions made in deriving the necessary control rod investment to shut down a reactor under all conditions of temperature and irradiation are examined and it is shown that, for maximum economy in investment, the control rod pattern must be carefully chosen. The effect of locally removing control rods from a fully shut-down reactor is illustrated. Reactor flux stability is examined, both in the radial/azimuthal and axial directions, and it is concluded that some form of control is necessary to prevent the former, but not the latter, possible instabilities. The problems associated with reactor start-up are discussed and the development of multi-group bulk control rod lifts is traced starting from the single-group lift as used at Calder Hall. It is shown that axial flux distortion is thereby reduced, but that, unless the control rod pattern is carefully chosen, radial/azimuthal flux distortions can give local high temperatures in the fuel elements. Bulk reactivity faults, caused by all rods moving simultaneously, are shown to be very severe, although their severity depends upon the relative disposition of the groups of rods when the reactor passes through criticality; the necessity to provide interlocks to high safety standards to prevent the occurrence of such faults is demonstrated. It is shown, nevertheless, that fast start-ups can be achieved on this type of reactor provided certain basic design requirements can be economically met. Part-load operation of a reactor is discussed, and methods of overriding the xenon poison following a load reduction are described. Using large digital computing machines, a method of calculation is described that enables reactor transient conditions in 3 dimensions to be examined. A one-dimensional method for transient calculations is also presented. (auth)

38429 (A/CONF.28/P/182) REACTOR SAFETY ANALYSIS AS RELATED TO REACTOR SITING. F. R. Farmer (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch, Risley, Lancs, England). May 1964. 13p.

Safety aspects involved in the siting of various types of power reactors are discussed. The concept of "maximum credible accident" is investigated, as regards its incapability of providing a yardstick for the comparative safety of various types of reactors. Siting regulations are outlined. (T.F.H.)

38430 (A/CONF.28/P/183) THE SAFETY OF U.K. GAS COOLED REACTORS—A REVIEW. G. R. Bainbridge (United Kingdom Atomic Energy Authority. Reactor Group, Risley, Lancs, England), L. F. Bowles, L. Cave, J. R. Harrison, and J. M. Yellowlees. May 1964. 15p.

Improvements in the safety characteristics of Calder Hall reactors resulting from operational experience and safety studies are described. The safety of the Windscale AGR and other AGR concepts is analyzed. Future prospects for safety requirements in gas-cooled power reactors are discussed. (T.F.H.)

38431 (A/CONF.28/P/294) TRENDS OF NUCLEAR POWER DEVELOPMENT IN THE USSR. N. M. Sinev, B. B. Baturov, and V. M. Shmelev (U.S.S.R.). May 1964. 18p.

A comparative analysis of economic efficiency of nuclear power stations is made, and the different versions of nuclear power development with reactors of various types are evaluated. Conclusions as to the future trends of nuclear power generation are presented. (C.E.S.)

38432 (A/CONF.28/P/295) INTERNATIONAL COOPERATION AND NUCLEAR REACTOR PROJECT DEVELOPMENT. I. D. Morokhov, V. S. Kandaritskii, and U. V. Arkhangelskii (U.S.S.R.). May 1964. 10p.

International cooperation in nuclear reactor project development is described. Mutual visits, exchange of scientific and technical information, bilateral agreements at governmental level, cooperation in the Joint Institute of Nuclear Research, international cooperation in the field of nuclear power, cooperation in personnel training, and cooperation in IAEA are discussed. (C.E.S.)

38433 (A/CONF.28/P/304) TRENDS IN WATER-MODERATED WATER-COOLED POWER REACTOR DESIGN. A. Ya Kramerov, Yu. V. Markov, S. A. Skvortsov, V. A. Sidorenko, B. P. Denisov, E. V. Kulikov, Yu. P. Sorokin, V. V. Stekolnikov, A. A. Hohlachev, and V. P. Tatarnikov (U.S.S.R.). May 1964. 16p.

Considerations for selecting ratings and design parameters for water-moderated water-cooled reactors of progressive design are discussed, and certain analytical techniques for parameter optimization are presented. (auth)

38434 (A/CONF.28/P/305) START-UP AND ADJUSTMENT OF WATER-MODERATED WATER-COOLED POWER REACTOR AT NOVO-VORONEZH ATOMIC POWER STATION. G. L. Dunin, V. A. Sidorenko, S. A. Skvortsov, M. A. Borisov, F. Y. Ovchinnikov, V. P. Denisov, V. V. Stekolnikov, A. A. Khokhlachov, and B. S. Yasvenko (U.S.S.R.). May 1964. 10p.

The basic procedures followed in the startup and adjustment program for water-moderated water-cooled reactors are outlined. The basic stages of adjustment and startup of the reactor and the auxiliary equipment are described, and some improvements and modifications carried out during its adjustment are discussed. The analytical values of physical, thermal, and hydraulic parameters are compared with the variables measured during testing and startup of the reactor and during the period of reaching full rated capacity. (auth)

38435 (A/CONF.28/P/306) EXPERIMENTAL PRESSURE VESSEL TYPE REACTOR FOR STUDIES IN BOILING AND STEAM SUPERHEATING. I. N. Sokolov, V. I. Gritskov, P. N. Bogdanovich, E. V. Kulikov, S. A. Skvortsov, V. P. Spasskov, V. I. Plutinsky, I. A. Philatyev, and A. A. Hohlachev (U.S.S.R.). May 1964. 16p.

In the USSR, construction work is being completed on an experimental reactor of the pressure vessel type to study problems of boiling and nuclear superheating of vapor inside the reactor. The installation scheme of a universal type is considered in which it is possible to conduct investigations on boiling and vapor superheating problems, within a wide range of heat transfer medium parameters. The reactor provides an electrical capacity of approximately 50 megawatts; it is possible to obtain saturated vapor with pressures ranging from 30 to 100 atm, and also vapor with a pressure of 90 atm and nuclear superheating of up to 500°C. The layout of the vessel and the active zone of the reactor designated for operation with fuels of various enrichment and for various parameters of the heat-transfer medium are described. The research and engineering work program to be carried out on the experimental installation is discussed in detail. (auth)

38436 (A/CONF.28/P/307) THE ARBUS—ORGANIC COOLED AND MODERATED NUCLEAR POWER STATION. K. K. Polushkin, I. Ya. Emelyanov, P. A. Delens, et al. (U.S.S.R.). May 1964. 19p.

The 750 kw(e) nuclear power plant for use in remote, difficult-to-reach areas is described. It consists of separate modules (each weighing up to 20 tons), the mounting of which takes two or three months. An organic fluid (hydrostabilized gas oil) is used as a coolant and moderator. The reactor and fuel elements are described. The reactor and the primary circuit equipment are made of carbon steel. There is no biological shielding at the plant except the reactor itself. A system for coolant regeneration is described. The reactor start-up and the nuclear power plant operation at loads are described. The nuclear power plant was brought to 100% power on August 11, 1963. Some information on plant test operation is presented. The results are in a perfect agreement with design criteria. It is shown that the successful operation of the plant permits construction of more powerful stations with an organic cooled and moderated reactor. (auth)

38437 (A/CONF.28/P/308) START-UP AND PILOT OPERATION OF THE FIRST UNIT OF THE BELOYARSK NUCLEAR POWER STATION AFTER I. V. KURCHATOV. A. N. Grigoryants, V. P. Nevskii, L. A. Kochetkov, B. G. Ivanov, P. I. Aleshchenkov, A. G. Phylippov, B. G. Dubovskii, M. E. Minashin, M. A. Altshuller, and L. V. Konstantinov (U.S.S.R.). May 1964. 16p.

Pilot operation of the first unit of the Beloyarsk nuclear power station is described. The first unit comprises a uranium–graphite tube type power reactor, steam generator which produces saturated steam, and high pressure turbogenerator operating on nuclear superheat steam. The main feature of the first unit start-up is that the start-up and in particular reactor heating from a cold state is obtained without a heat external source using only reactor inherent heat of uranium-235 nuclear fission. This feature makes it somewhat difficult to put the reactor into operation but at the same time this is absolutely necessary for a superheat nuclear power station. Research and experimental work before and during reactor pilot operation is discussed, as well as simultaneous checking-up of power plant equipment, operation at loads, the steady-state unit early stage operation, and setting-up of separate systems,

control and measuring devices, and automation instruments. (auth)

38438 (A/CONF.28/P/309) DEVELOPMENT OF SUPERHEATING POWER REACTORS OF BELOYARSK NUCLEAR POWER STATION (BAZS) TYPE. N. A. Dollezhal, I. Ya. Emelyanov, P. I. Aleshchenkov, et al. (U.S.S.R.). May 1964. 19p.

The development of heat removal systems and technological flow sheets of a power station with direct-cycle, uranium-graphite, tube-type reactors and nuclear superheating of steam is discussed. The problems encountered during design and experimentation with a 200-Mw plant are considered. Fuel element and channel designs, their position in the graphite-moderated core and operation conditions, and lattice spacing are discussed, as well as many features of the reactor concepts characteristic of different coolant flows and power ratings. The main features of the direct-cycle concept, namely feed water regime and steam reactivity problems, are mentioned. Flow diagrams are described, and the advantages of the direct-cycle concept are pointed out. (auth)

38439 (A/CONF.28/P/310) SMALL-GABARIT ATOMIC POWER PLANT TES-3. N. M. Sinev, A. K. Krasin, I. F. Bichkov, et al. (U.S.S.R.). May 1964. 11p.

The portable power station TES-3, a two-circuit steam-turbine plant using a water-moderated heterogeneous reactor cooled with water at 130 atm, is described. Once-through steam generators produce superheated steam at 20 atm and 285°C. The characteristics of the plant are given, and measurements are compared with theoretical predictions. (D.C.W.)

38440 (A/CONF.28/P/311) SODIUM-COOLED FAST REACTORS. A. I. Leipunskii, O. D. Kazachkovskii, I. I. Afrikantov, M. S. Pinhasik, N. V. Krasnoyarov, and M. S. Poydo (U.S.S.R.). May 1964. 9p.

Based on the operational experience of the experimental fast reactor BR-5, the prototype of a full-scale fast-reactor power station of 350 Mwe and 1000 Mwt is being designed. Fuel elements are stainless steel tubes filled with uranium and plutonium dioxides, ribbed for spacing, and inserted into subassemblies. The radial blanket consists of cylindrical elements filled with depleted UO_2 and inserted into subassemblies. The reactor is controlled by B_4C elements. Burnup reactivity change is compensated by movable subassemblies. Reactivity changes due to heat and power rise are compensated by B_4C subassemblies. Similar B_4C subassemblies are used for reactor scram. The shielding, fuel charge and discharge mechanism, pumps, heat exchangers, and steam generators are described, and the coolant parameters of the primary, secondary, and third loops are given. (M.J.T.)

38441 (A/CONF.28/P/314) OPERATIONAL EXPERIENCE OF THE FIRST ATOMIC POWER STATION AS AN EXPERIMENTAL SET-UP. G. N. Ushakov, L. A. Kochetkov, V. G. Konochkin, V. S. Severjanov, V. Y. Kozlov, O. A. Subnitsin, N. T. Belinskaja, P. N. Slusarev, and V. A. Ivanov (U.S.S.R.). May 1964. 16p.

The experimental in-pile loops in the Kurchatov Atomic Power Station and some of the studies being conducted with them are described. The performance of the graphite core after 10 years operation at up to 800°C is described. The design and testing of the channels and tubular fuel elements are discussed. Results are given of the investigation of the radiolysis of water and superheated steam and of the radioactive deposits from steam on turbine vanes. (D.L.C.)

38442 (A/CONF.28/P/316) PROGRESS OF POWER ENGINEERING IN THE USSR AND ATOMIC POWER PLANTS. A. M. Nekrasov and G. S. Selevinsky (U.S.S.R.). May 1964. 14p.

The development of power production in USSR and the program for the future are discussed. The possible application of nuclear power plants is considered, and it is concluded that they will be used in the European section of USSR where fuel and hydropower resources are limited. The economic aspects of nuclear power plants are discussed. (D.L.C.)

38443 (A/CONF.28/P/319) USE OF NUCLEAR REACTORS FOR DISTRICT HEATING AND HEAT SUPPLY. A. C. Gorshkov, Yu. I. Koryakin, A. A. Loginov, and E. Ya. Sokolov (U.S.S.R.). May 1964. 12p.

The possibility of using nuclear reactors for steam generation and district heating is analyzed, and it is shown that nuclear reactor plants can and must be used for district heating purposes. (auth)

38444 (A/CONF.28/P/328) HEAT REMOVAL FROM THE REACTOR FUEL ELEMENTS COOLED BY LIQUID METALS. V. I. Subbotin, P. A. Ushakov, P. L. Kirillov, M. K. Ibragimov, M. N. Ivanovsky, E. V. Nomophilov, D. M. Ovechkin, D. N. Sorokin, and V. P. Sorokin (U.S.S.R.). May 1964. 20p.

New data are given on heat transfer to liquid metals. As a result of temperature distribution measurements in the flow of sodium, sodium-potassium alloy, lithium, mercury, a general equation for temperature distribution in different liquid metals was obtained, and diffusivity heat transfer coefficients in round tubes were determined, and also some statistical characteristics of turbulent flow were evaluated. The problems of heat transfer in slab fuel elements are considered. The problems of heat transfer to liquid metals in parallel flow through bundles of circular rods are considered. The results of the investigation of average heat transfer coefficients in shell-and-tube heat exchangers of "liquid metal-liquid metal" type with different lattice pitches and with different lengths of the tubes are presented. The results of experimental heat transfer studies when changing aggregate conditions of liquid metals are given. (T.R.H.)

38445 (A/CONF.28/P/355) SOME ASPECTS OF POWER REACTOR OPTIMIZATION BY NONUNIFORM MATERIAL DISTRIBUTION. E. S. Glushkov, E. I. Inyutin, V. P. Kochergin, I. P. Markelov, G. I. Marchuk, N. N. Ponomarev-Stepnoy, and V. A. Chuyanov (U.S.S.R.). May 1964. 19p.

The problem of optimizing various parameters of power reactors by means of non-uniform distribution of materials within the reactor is presented. Theoretical substantiation and methods are described whereby the reactor systems can be analyzed so as to obtain optimal parameters of the reactor. The relevant computer code is described. Experimental techniques and results of experiments in varying the energy release profiles by means of non-uniform distribution of fissionable material and moderator within the core are discussed. The experiments were carried out on critical assemblies with light-water, organic and beryllia moderators, and consisted of measuring the flux and fission integral distribution for various laws of distribution of fissionable material and moderator. The experimental results are compared with the theoretical characteristics of systems. (auth)

38446 (A/CONF.28/P/359) EXPERIMENTAL STUDY OF PHYSICAL CHARACTERISTICS OF WATER-

MODERATED REACTORS FOR SMALL NUCLEAR POWER STATIONS. E. I. Inutin, M. N. Lantsov, I. G. Morozov, A. I. Nevinitsa, E. A. Plaksin, and G. I. Sidorov (U.S.S.R.). May 1964. 20p.

Experimental results are given on the physical characteristics of water-moderated and -cooled reactors with uranium fuel enriched to 10 to 20 percent. The results were obtained from 1959 to 1963. Such reactors are useful in small atomic power plants (including mobile plants). The analysis of experimental results, as a rule, is made on multigroup theory basis. Critical assemblies (cold and hot), on which the experiments were performed, are described. For more accurate determination of design values of fuel charge in cores and reactivity excess, a number of critical assemblies were constructed. These assemblies differed in core content (types of fuel elements, fuel enrichment, lattice pitch, etc.) and configuration. Excess reactivity determination of a full-sized core was carried out by integration of experimental values against the core height. In these experiments core height variation was accomplished by a variable charge of a heterogeneous absorber, by boron contaminating the moderator, as well as by core radius variation. The common method of measurement was modified according to the peculiarities of the systems with a great number of channels with small passage section. The great excess reactivity inherent to the reactors considered, and the peculiarities of temperature effect of their cores require severe reactivity compensation. The paper contains the experimental results on determination of compensation effectiveness of rods with variable construction and content (Eu, Ag, B, Cd) of compensating lattice and burnable additives. In addition, results are given on determination of perturbation of heat release field by core lattice regularity disturbances (including the case of absorption change of controls). Emphasis is placed on experimental investigations of interference of controls. The distribution of compensating unit functions according to their use for physical profiling water-water reactor cores is considered. Considerable reactivity changes with temperature are inherent to water-moderated and -cooled reactors. Experimental results on studies of warm-up curves for such reactor cores within the temperature range 20 up to 200° to 300°C are given. The warm-up of undisturbed (with regular lattice without compensating elements) cores as well as of critical assemblies with disturbed lattices practically accomplished in water reactors was carried out. Thermal neutron field variation across the lattice cell with temperature was investigated experimentally. Experimental data on control compensating effectiveness variation with core temperature are given. (auth)

38447 (A/CONF.28/P/369) SOME PHYSICS CALCULATIONS ON THE PERFORMANCE OF FAST POWER REACTORS. A. I. Leipunskii, O. D. Kazatchkovskii, M. V. Troyanov, et al. (U.S.S.R.). May 1964. 16p.

The main feature of fast reactors is the possibility to develop their own fuel. The rate of this development is defined both by the characteristics of the reactor itself and by the parameters of the fuel cycle: burnup, reprocessing time, and fuel losses during reprocessing. Equations describing reactor breeding both for one kind of fuel and for the case of different fuel mixtures are formulated. The dependence of fuel doubling time on the characteristics of fast reactor developing system is obtained. Reactor characteristics are defined primarily by the kind of fuel and by possible heat transfer conditions in the core and blankets. Two different possibilities are considered from this point of view. The first one is connected with the use of oxide fuel and with such heat transfer conditions that are based on design studies and experiments. The second possibility is connected with the future increase of coolant parameters, of its heating and with the use of thin-canned carbide fuel element. Heat engineering restrictions in powerful reactors do not permit placing sufficient amounts of fuel and fertile material in the core. In this connection the means to decrease the volume fraction of coolant and to increase fuel and fertile material content are considered. One way to achieve this is to flatten the core, and another one is to vary physical properties over the core. The significance of power distribution flattening and different means of its realization are considered. Power distribution flattening is shown to allow the improving of reactor physical characteristics. Both the different physical reactor characteristics as a function of composition and the significance of different materials for neutron balance are analyzed. Reactor breeding rate as a function of reactor characteristics and reprocessing parameters is shown on the basis of doubling time comparison. Optimum power density, from the doubling time point of view, and its dependence on the reactor power at different original assumptions is considered. The results of thorium cycle studies for fast reactors are given; a joint cycle is proposed where plutonium and uranium-233 are used as fuel and uranium-238 as fertile material in the core. Thorium serves as fertile material in the blanket. As a result uranium-233 is generated in blankets and plutonium in the cores. The principal characteristics of separate and joint systems are analyzed, doubling time comparison is performed, and the rate of joint system breeding is shown to be not much less than plutonium system breeding rate. (auth)

38448 (A/CONF.28/P/371) ON DYNAMIC STABILITY OF NUCLEAR POWER PLANTS. P. A. Gavrilov and L. N. Podlazov (U.S.S.R.). May 1964. 18p.

Stability of nuclear power plants with a steam generator operating at a free level is considered when turbogenerator load and reactivity are changing. A dynamic equation system is given and confirmed. Transfer functions for several parameters are obtained in the form suitable for different modes of regulation including self-regulation. It is shown that in most practically interesting cases transfer functions may be used as fractional rational functions with a characteristic equation of not higher than the fifth power. A method of defining plant general parameters is presented ensuring a plant aperiodic stability with load and reactivity perturbations. Nomograms are given to determine the plant dynamic characteristics. The nomograms may be directly used to select optimal characteristics and analyze dynamics of designed reactor and control systems. As an example, the model developed is applied to the analysis of the dynamics of an organic-cooled and -moderated power station. It is shown that the dynamic parameters are in the vicinity of the aperiodic stability boundary when turbogenerator load is changing. Some recommendations are given aiming at improving dynamic characteristics of the plant. The results of the dynamics on an analog computer are compared with those on nomograms. A choice of regulation model of the power plant is provided. It is proved that there is no need for an automatic power regulator, and that it is possible to operate nuclear power plants at a self-regulation régime. (auth)

38449 (A/CONF.28/P/376) COMPENSATION OF LARGE CHANGES IN REACTIVITY BY MEANS OF CORE

LATTICE DEFORMATION. G. A. Bat, G. B. Muhina, D. M. Parfanovich, D. C. Klochkov, V. C. Muhortov, H. M. Truhachev, and D. I. Sheffer (U.S.S.R.). May 1964. 16p.

Prolongation of the power reactor life entails increasing the reactivity margin of the newly loaded reactor, and, therefore, calls for the development of an effective system compensating for this margin. Along with the conventional systems such as the shim rods and assemblies, burnable poisons, mixtures of heavy and light water, it is deemed advisable to discuss the possibility of controlling the reactivity by means of a relatively slow deformation (variation of the effective spacing) of the core lattice in the moderator. This is most feasible in the case of liquid-moderated reactors with channel type cores, as in the icebreaker, Lenin. Deformation of the lattice is, in a sense, similar to controlling the reactivity by changing the concentration of the heavy and light water mixture, in that its effect does not cause considerable distortions of the energy release field corresponding to the insertion of the permissible number of the absorbing rods. However, the flexibility of the suggested method is rather high. The difficulties involved in the development of such control systems are owing to the necessity to have a considerable number of kinematic pairs in accessible points of the reactor, to arrange "light" but quick-acting control and safety components in the movable lattice, and to adapt the system to operation at a varying temperature effect. The work on the development of the new control system was carried out along three main lines: critical experiments; mathematical description, including calculation codes for high-speed computers; and designing of the core. Several series of critical experiments confirmed the effectiveness of this method of control, and made it possible to determine its physical peculiarities and work out simple but sufficiently accurate computer codes. The experiments were carried out with individual fuel elements and with bundles–channels. Several design schemes of cores with deformable lattice are described. (auth)

38450 (A/CONF.28/P/380) NUCLEAR SAFETY REGULATIONS FOR POWER REACTORS IN THE USSR. G. A. Gladkov, G. A. Bat, B. A. Buinitskii, Y. G. Nikolaev, and V. A. Sidorenko (U.S.S.R.). May 1964. 7p.

A guide providing nuclear safety of power reactors was developed in the USSR. The guide is obligatory for all research and designing organizations. The guide comprises a code of requirements to the reactors and auxiliary systems, designed to exclude the possibility of uncontrolled power growth. The primary attention is devoted to the automatic control and emergency shielding systems. The guide regulates the measures providing the impossibility of fast reactivity introduction compared to the portion of delayed neutrons during all unstable processes: power variation, heat-up, and cooling after emergency shielding action. The guide introduces the requirements contributing to emergency shielding reliability. The conditions which the core construction must satisfy are established from the point of nuclear safety. A discussion on the operative rules is presented. (auth)

38451 (A/CONF.28/P/382) DYNAMICS OF WATER-MODERATED WATER-COOLED REACTORS AT ACCIDENTAL DROP OF COOLANT CIRCULATION. G. N. Poletaev (U.S.S.R.). May 1964. 18p.

A system of equations to be employed for computing the change of the coolant circulation in the primary circuit of the multipool water-moderated water-cooled reactor when the operating conditions of the circulating pumps are changed or disturbed is presented. Conditions of system consistency are cited. Analytic solutions of some cases are given. A detailed analysis of the circulating pump de-energizing or breaking is made. Typical time constants for drop of circulation are obtained and analyzed for different reactors employing various types of circulating pumps. The analytic solutions are compared to the computer calculations and experimental data. Performance of a bench test for determining the drop of coolant circulation is highly recommended. An analysis is made of the heating conditions in the water-moderated water-cooled reactor in case of pump de-energizing. Reactors with various types of fuel elements are considered. Criteria are obtained which will allow the operators to keep the heating conditions in the reactor within the specified limits (for instance, lack of coolant bulk boiling and heat exchange crisis or maximum tolerable temperature of the fuel element in case of heat exchange crisis). Some calculated data are cited which are compared to available experimental data. (auth)

38452 (A/CONF.28/P/417) FUEL CYCLE PHYSICS AND ECONOMICS FOR HEAVY WATER REACTORS. L. Zettergren and B. Pershagen (Aktiebolaget Atomenergi, Stockholm). May 1964. 17p.

The reactor program, based on the prospective energy needs over the next two decades and the most economical way of developing the overall power system, is briefly outlined. From the aspect of fuel cycles two important items influence the choice of a particular reactor type, namely long range fuel utilization and fuel cycle economics. The prospective consumption of natural uranium is compared for different reactor types, including the heavy water moderated Marviken reactor type, the light water moderated advanced converter reactor, and the fast breeder reactor. Fuel cycle costs are compared with special regard to the effects of feed cost, fabrication and processing costs, uranium and plutonium credit, and burnup. The characteristics of current Swedish fuel cycle policy are discussed. This involves consideration of the use of natural or enriched fuel, the need for chemical reprocessing of spent fuel, and the possibility of plutonium recycling. Presently adopted fuel cycles for the 200 Mw(e) Marviken reactor, which has entered the construction phase, and for the 350 Mw(e) PHWR conceptual design are discussed. The Marviken reactor is being designed for on-power refueling, whereas PHWR uses refueling at shutdown. Both reactors use fuel management as a means of reactivity control and power shaping. The implications of these features for reactor operation and fuel cycle costs are evaluated. The operational problem of approach to fuel cycle equilibrium is indicated. It is shown that there is an economic incentive to use slightly enriched fuel in the heavy water reactors under consideration, whereas no chemical reprocessing of spent fuel is required. As a possible development the use of plutonium recycle is considered. The value of plutonium and the possibility of self-sustained recycling with natural uranium feed are discussed. Different refueling schemes, plutonium feed compositions, and cost assumptions are included. Different heavy water reactor types are compared, including cooling with pressurized water, saturated steam, and internally superheated steam. Optimization of reactor parameters for the use of plutonium is considered. (auth)

38453 (A/CONF.28/P/426) THE DESIGN AND DEVELOPMENT OF THE TOKAI HOLLOW-ROD FUEL ELEMENT. R. Sagane (Japan Atomic Power Co., Tokyo), T. Yoshioka, N. L. Franklin, B. E. Eltham, P. T. Fletcher, and B. C. Woodfine. May 1964. 20p.

The Tokai Power Reactor is the only Magnox reactor designed in U.K. adopting hollow uranium tube fuel. The paper describes the various aspects of the development works in the following sections: special features of the hollow-rod fuel element; design and development program for Tokai fuel; and development of special manufacturing techniques. (auth)

38454 (A/CONF.28/P/436) EVALUATION OF POST-INCIDENT COOLING SYSTEMS OF LIGHT WATER POWER REACTORS. Hideo Uchida, Akira Oyama, and Yasumasa Togo (Tokyo Univ.). May 1964. 19p.

The significance of post-incident cooling systems is evaluated in connection with so-called "maximum credible accident (MCA)" of light-water power reactors. In evaluation of a core spray system, non-uniformity of core spray flow distribution is taken into account. Introducing experimental data of core spray flow distribution and spray heat transfer, quantitative calculations are made of percentages of fuel segments ruptured in case of loss-of-coolant accidents. Calculations are made on JPDR (BWR, 12.5 Mw(e)) design data. Stability criteria for spray cooling are also discussed. In evaluation of a container spray system, reduction factors of F.P. release are calculated, and relative significance of container spray systems is discussed. In order to experimentally evaluate post-incident cooling systems (core spray, safety injection, and container spray systems), Project SAFE (Safety Assessment and Facilities Establishment Project) was established in Specialists Committee for Study on Nuclear Safety of Japan Atomic Industrial Forum. During first period of this Project (from April 1963 to September 1964), amounts of flushed coolant at loss-of-coolant accidents are evaluated by a non-nuclear model, as well as temperature and pressure transients of a container. It is also aimed to run basic experiments on effects of types of spray nozzles and its arrangement, spray heat transfer and wash-out effect, for the purpose of comparing calculated results with experimental data. Experimental results obtained so far are reported. (auth)

38455 (A/CONF.28/P/459) THE UNDERGROUND CONTAINMENT OF THE LUCENS EXPERIMENTAL NUCLEAR POWER PLANT. E. Binggeli (Bonnard et Gardel, Ingenieurs-Conseil, Lausanne, Switzerland), P. Verstraete, and A. Sutter. May 1964. 15p.

The 30 Mw(t) experimental nuclear power station presently under construction at Lucens is equipped with a pressure-tube reactor, moderated by heavy water, and cooled by carbon dioxide. In view of the underground location of the plant an economic design for the containment was developed. Extensive investigations on the geology and hydrology of the site have shown that the rock mass, a porous homogeneous and highly compact molasse, typical of sedimentary configuration, can be used as a filter for particulate radioactivity as well as temporary storage for fission gases released after a severe accident without undue risk to the surroundings. The additional lining of the entire reactor cavern, consisting of a multilayer coating of bitumen and thin aluminum foils, will contain the initial effects of a severe reactor accident. The resulting overpressure will be partly reduced through cooling effects and condensation of steam. The remaining overpressure is then reduced by opening decompression valves equipped with filters which will release the contained gases, into the surrounding porous rock. Therefore the potential danger entailed by a highly contaminated atmosphere under pressure is greatly diminished. The tests in the experimental cavern have shown that during decompression gases will flow only a limited distance into the rock; further progression is very slow and occurs by molecular diffusion. (auth)

38456 (A/CONF.28/P/495) SAFETY FEATURES OF THE DON REACTOR CONCEPT. A. Alonso (Spain. Junta de Energía Nuclear, Madrid) and B. L. Hoffman. May 1964. 16p.

The DON is a heavy-water-moderated, organic-cooled, natural-uranium-fueled type of reactor. A 30 MWe version of this concept is presently being studied by the J.E.N. to serve as a prototype for large nuclear power plants. The safety aspects of the whole reactor concept are analyzed. The reactor is a low pressure system due to the physical properties of the organic and the operating conditions of the moderator, this being one of the major advantages of this reactor concept. Equations were developed and programmed to describe the release of radioactive contaminants to the atmosphere from credible accidents. Different types of containment schemes are analyzed to prove that simple engineering features are enough to reduce the release below the permissible limits. Mechanical and thermal barriers have to be located within coolant and moderator. The integrity of these barriers has to be maintained throughout the reactor life, thus posing a problem to be studied. A preliminary chemical compatibility study among the various components suggested for the DON prototype shows that no hazardous chemical reactions are likely to occur. Reactor stability and its influence on nuclear accidents are discussed. The radiological consequences of reactor operation are analyzed to prove that reactors of this type can be built and operated in normal locations without undue risk to the health and safety of the public and without adding costly or novel engineering safety features. (auth)

38457 (A/CONF.28/P/514) CENTRALE NUCLEAIRE DES ARDENNES SPECIAL FEATURES AND IMPROVEMENTS IN COMPARISON WITH SIMILAR EXISTING PLANTS. P. Erkes (Bureau d'Etudes Nucleaires, S. A., Brussels) and P. Grau. May 1964. 20p.

The SENA power plant will be equipped with a PWR reactor that feeds a single turbo-generator unit having a net electrical capacity of 266 Mw(e). The plant will be installed in a cavern. The special features, plant cost and its economic perspectives are discussed. The principal characteristics and present state of construction are summarized. (auth)

38458 (A/CONF.28/P/516) "HERMES" FAST NEUTRON SUPERHEATER REACTOR. G. Tavernier, J. Chermanne, C. Descamps, M. Egleme, E. Fossoul, E. Jonckheere, J. Morelle, M. Stievenart, L. Tollet, and J. Van Dievoet (Société Belge pour l'Industrie Nucléaire, Brussels). May 1964. 16p.

Dry steam can be produced, either by a classical reactor with direct cycle or indirect cycle through a steam generator, either through a Loeffler's cycle utilizing one single reactor as the thermal source for the plant. A reactor of the module type contains a pressure tube of relatively small diameter containing the fuel elements and used as a channel for the steam. These pressure tubes are juxtaposed. The modules fit into a honeycomb structure. Since it is a fast reactor, a broad choice of cladding and dilution materials is also possible for the fuel elements. Partial loadings and unloadings are performed to optimize power distribution. Among the advantages of the module pattern one can mention that the confinement of the fissile material is insured in case of an accident and that the possible reac-

tivity insertion during the partial or total water flooding of the core is easily controlled. (auth)

38459 (A/CONF.28/P/518) PRACTICAL RESULTS AND PROSPECTS OF THE USE OF SOLUBLE POISON IN THE PRESSURIZED WATER REACTORS. M. Plumier (Ateliers de Constructions Electriques de Charleroi. Division Nucleaire, Belgium), P. Stacquez, P. Dozinel, R. Muylle, M. Preat, G. Beuken, M. Gueben, and L. Maesen. May 1964. 14p.

Control by chemical shims has several important advantages for nuclear power plants of the pressurized water type. The power operation of the BR-3 plant with 125 and 350 ppm boron as boric acid in the coolant under various conditions is described, and the problems encountered during the operation are examined. The effects of chemical shim control using boron on the design of pressurized water type plants are considered, with particular attention on the hydraulic systems and waste treatment. (D.L.C.)

38460 (A/CONF.28/P/522) PRESSURE VESSEL FOR THE FIRST CZECHOSLOVAK NUCLEAR POWER STATION. J. Hauer, St. Havel, J. Němec, and St. Štěpánek (Lenin (V. I.) Works, Pilsen, Czechoslovakia). May 1964. 22p.

The pressure vessel reactor fueled with pin type fuel elements of natural uranium, moderated with heavy water, and cooled with gas is discussed. The basic dimensions of the reactor pressure vessel resulted from the conception and from the fixed power rating of 150 Mw(e). In the prescribed minimal spacing of the fuel channels large vessel dimensions and wall thickness were reached which are difficult to manufacture to weld and check. That is why the design must solve the question of optimal dimensions and designs in most troublesome parts of the vessel as the cover, the flanged joint, the conical support, and above all the inlet and outlet connecting branch for the cooling gas ducting. These problems were solved theoretically and experimentally on models by means of tensometry and photoelasticimetry. Various effects on the magnitude of stress concentration in places of weakness in the cylindrical pressure vessel due to connecting branches were studied: the magnitude and shape of the hole, the number of holes on the circumference, the reinforcement of the hole with connecting branch, and the local transition modification of the branch into the pressure vessel wall. (auth)

38461 (A/CONF.28/P/523) DEVELOPMENT AND CONSTRUCTION PROBLEMS OF THE FIRST CZECHOSLOVAK NUCLEAR POWER STATION. Jan Hůlovec, Jan Jůza, Arnošt Komárek, Jan Kořenek, Vladimír Křížek, Ján Tomčík, and Karel Wagner (Lenin (V. I.) Works, Pilsen, Czechoslovakia). May 1964. 17p.

The main attention was devoted to the pressure vessel development for the gas-cooled heavy water reactor. The material was carefully chosen and the technology, especially welding, was tested. Problems of experimental strength were solved on many model installations from which the shortened model is nearing the completion. With respect to the high power rating and short time of the fuel exposition incidental to it, the on-load fuel exchange has become a necessity; great attention was therefore devoted to the development and design of the charge-discharge machine. Both separate parts and the whole prototype of this machine were functionally tested. Mechanisms of all control and scram rods were subjected to versatile tests on a special stand that permitted experiments with model mechanisms at the working temperature and pressure of the cooling CO_2. The reliability and quality of the control system was tested on a prototype control loop with electronic models for the reactor kinetics. Technology and operational ability of the steam generators were tested on fuel-scale model of one section, great attention being devoted to the tightness. The effects of temperature shocks in piping due to little thermal capacity of the reactor at scramming were investigated. The applicability of unified parts of a classical power station turbine for working conditions in a nuclear power station were discussed especially with respect to greater moisture content of the steam. (auth)

38462 (A/CONF.28/P/525) ON SOME DYNAMIC PROPERTIES OF A POWER STATION WITH HEAVY-WATER GAS-COOLED REACTOR. Pavel Stirsky (Výzkumný Ustav Energetický, Prague) and Jan Hůlovec. May 1964. 16p.

Dynamic properties of the main technological equipment for the first Czechoslovakian nuclear power station are analyzed, and the control system ensuring operation at the given power level of the turbo-generator is described. Some transients of the atomic power station caused by equipment and regulating system failures are analyzed. (auth)

38463 (A/CONF.28/P/532) METHODS OF OPTIMALISING THE PARAMETERS OF NUCLEAR POWER STATION WITH HEAVY-WATER, GAS-COOLED REACTOR. Ladislav Bohal (Czechoslovakia. State Design Inst., Prague), Miloš Drahný, Rostislav Havliček, and Karel Janůska. May 1964. 20p.

The methodics of the optimization of parameters for a nuclear power station is founded upon a consistent application of the criterion of optimality for the use of all degrees of freedom to achieve the optimum of this criterion. Because of its intricacy the optimization so considered requires the use of a digital computer and because of it, there is required the creation of a full mathematic model. (auth)

38464 (A/CONF.28/P/533) THE SEFOR REACTOR — ASPECTS OF INTERNATIONAL COOPERATION. W. Schnurr (Kernforschungszentrum, Karlsruhe, Germany) and J. R. Welsh. May 1964. 13p.

The Southwestern Experimental Fast Oxide Reactor, a sodium-cooled, plutonium-fueled experimental fast oxide reactor with a thermal power of 20 MW, is under construction at Fayetteville, Arkansas, USA. It is being built by the General Electric Atomic Power Equipment Department for the Southwest Energy Associates, a considerable contribution to the financing being made by the Gesellschaft für Kernforschung m.b.H., Karlsruhe. After a detailed discussion of the technical and scientific incentives and a review of the historical development of the project, the paper describes the legal relations among the various partners. It further covers the problems of financing and the organization which was created in order to guarantee to all partners the necessary influence and control. Finally the question of the use of the obtained information and patents and the exchange of personnel and knowledge is discussed, with special consideration to existing international agreements. (T.R.H.)

38465 (A/CONF.28/P/535) SUPERHEAT REACTOR DEVELOPMENT IN THE FEDERAL REPUBLIC OF GERMANY. H. Kornbichler (Allgemeine Elektrizitätsgesellschaft, Frankfurt am Main). May 1964. 20p.

A superheat reactor with tubular combined boiling-superheat fuel elements was selected as a reference design. The reactor is briefly described, and the developmental work is summarized, including material tests; reactor physics studies; hydrodynamic and thermodynamic research; and fuel element calculations, fabrication, and testing. (D.C.W.)

38466 (A/CONF.28/P/536) DEVELOPMENT PROJECT OF A PEBBLE-BED POWER REACTOR. C. B. von der Decken, J. D. Lueders, O. Machnig, H. W. Schmidt, and R. Schulten (Brown Boveri/Krupp Reaktorbau GmbH, Mannheim, Germany). May 1964. 16p.

A project to investigate the application of the pebble-bed reactor type to a high-temperature, Th–U cycle power reactor and to lead to the design of a 500 Mw thermal prototype reactor is described. Major research and development studies will be on fuel elements, irradiation and corrosion behavior of graphite, mass transfer problems in the primary circuit, flow characteristics of a large pebble bed core, primary-circuit purification, burnup measurements of single balls, and neutron physics of U–Th–C systems. The reactor vessel, heat exchangers and blowers, fuel handling system, and their arrangement will be studied for technical performance, extrapolation to large systems, and economics. (M.J.T.)

38467 (A/CONF.28/P/537) A SODIUM-COOLED POWER REACTOR EXPERIMENT EMPLOYING ZIRCONIUM HYDRIDE MODERATOR. R. Harde and K. W. Stoeher (Internationale Atomreaktorbau G.m.b.H., Bensberg, Germany). May 1964. 19p.

A 20 Mw(e) sodium-cooled, zirconium hydride moderator reactor experiment, with steel-canned slightly enriched UO_2 fuel, was designed. Maximum Na temperature of 560°C will generate steam at 510°C and 85 atm. Some results of reactor physics experiments, development of moderator elements, testing of a low-alloy ferritic steel for high-temperature Na use, components development using Na loops, and study of steam tube rupture in Na-heated steam generators are given. Economics of the reactor are considered. (M.J.T.)

38468 (A/CONF.28/P/539) THE KARLSRUHE FAST BREEDER PROJECT. Wolf Haefele, K. H. Beckurts, E. Bojarsky, et al. (Kernforschungszentrum, Karlsruhe, Germany). May 1964. 15p.

The basic approach of a fast breeder reactor design using non-metallic fuel elements is outlined. The lower density and the trend to lower plutonium contents result in lower power densities. The use of non-metallic fuel elements brings an emphasis of the lower tail of the neutron spectrum. The high burn-ups required are the basic problem for a proper fuel element design. A set of integral reactor experiments is prepared: SNEAK (Pu fueled fast critical facility), STARK (coupled thermal fast reactor), SUAK (fast pulsed subcritical assembly), and SEFOR (fast reactor for excursion tests). Sodium, helium, and dry steam are considered to be possible coolants. Conceptual design studies and the development of key components are being made. (auth)

38469 (A/CONF.28/P/542) THE USE OF POWER REACTORS AS LARGE-SCALE RADIATION SOURCES FOR RADIATION CHEMICAL PRODUCTION. F. Herre, W. Herzog, S. Roesinger, W. Schuetze, and A. Wacker (Farbwerke Hoechst, Frankfurt am Main). May 1964. 14p.

A compound reactor, utilizing chemically the high-intensity radiation from a power-reactor core, is described. The chemical reaction takes place outside the reactor vessel, and thus the chemical plant takes over, in whole or in part, the function of the thermal shield. Such a compound reactor permits economical chemical production since it utilizes only the waste-radiation of the reactor, which must otherwise be annihilated in the radiation shield. (auth)

38470 (A/CONF.28/P/546) EFFECTS OF PEAK-LOAD FACTOR ON THE ECONOMY OF NUCLEAR HEAT-PRODUCING POWER PLANTS. POSSIBLE MEANS OF IMPROVING THE LOAD FACTOR. J. Halzl and M. Torma (Termoenergetical Design Inst., Budapest). May 1964. 19p.

The economics of using a small reactor in association with a condensing plant to produce electric power only and in association with a back-pressure plant supplying heat are summarized and possible ways of improving the load factor of nuclear heat-producing plants are reviewed, with consideration of the effects of such improvements on nuclear heat economy. (D.C.W.)

38471 (A/CONF.28/P/549) REVIEW OF ENGINEERING WORK FOR THE DRAGON PROJECT. G. Franco, H. W. Muller, S. B. Hosegood, and L. H. Prytz (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). May 1964. 15p.

The 20 Mwt Dragon reactor experiment will be a graphite moderated, helium cooled, high temperature reactor. The main aspects of the engineering work through the stages of design, manufacture, site construction, and testing which have all been affected by the features peculiar to this reactor, such as the use of helium as a coolant and consequent very high standard of leak tightness, the use of an uncanned ceramic fuel, the high coolant temperatures, and the extreme compactness of the plant. (M.J.T.)

38472 (A/CONF.28/P/550) NUCLEAR POWER STATIONS IN ITALY. A. M. Angelini (Italy. Ente Nazionale per l'Energia Elettrica, Rome). May 1964. 20p.

An outline is given of construction problems of the three Italian nuclear power plants (SIMEA, SENN, and SELNI) and of tests of nuclear and conventional components. Problems of the initial operation of the first two plants, especially concerning the fuel cycle program and the transporation and chemical treatment of irradiated fuel are illustrated. The effect of capital, fuel, operation, and maintenance costs on the final cost of producible energy is estimated. The computation of the natural kwh cost for plants equipped with both natural and enriched uranium reactors is described. (M.J.T.)

38473 (A/CONF.28/P/552) A METHOD FOR THE CALCULATION OF THREE-DIMENSIONAL FLUX AND TEMPERATURE DISTRIBUTIONS IN A MAGNOX REACTOR. COMPARISON WITH EXPERIMENTAL MEASUREMENTS TAKEN AT LATINA POWER STATION. R. Negrini (Societa Nazionale Metanodotti, Milan), M. Paoletti Gualandi, G. Ciancio, A. Del Buono, T. Marzullo, and B. Zaffiro. May 1964. 20p.

Predicting rating and temperature distributions is a three-dimensional problem, since the presence of discontinuous absorbers and control rods, partially inserted in the core, causes radial, azimuthal and axial distortions to the neutron flux distribution. The three-dimensional multiradial, multiaxial codes available at present cannot be applied to the gas-cooled reactors, on account of their large dimensions. A calculation method was developed which is an appropriate combination of 2 two-dimensional IBM-704 computer codes, the FTD-2 and the PDQ, both of which assume a constant flux shape in the third dimension. The method was checked against experimental results obtained from Latina nuclear power station during commissioning and operation; a satisfactory agreement was obtained. A proposal is made for using this method to assess the operation of magnox gas-cooled reactors by means of gas and can temperature analysis. (M.J.T.)

38474 (A/CONF.28/P/559) NUCLEAR POWER IN THE UNITED KINGDOM. William Penney (United Kingdom Atomic Energy Authority, London). May 1964. 15p.

Progress in the nuclear power program of the United Kingdom is described, together with plans for its extension. The future economic contribution of nuclear power to energy supplies is considered. (D.C.W.)

38475 (A/CONF.28/P/561) PLANNING FOR NUCLEAR POWER IN THE CENTRAL ELECTRICITY GENERATING BOARD'S SYSTEM. P. W. Cash and F. Faux (Gt. Brit. Central Electricity Generating Board, London). May 1964. 15p.

The United Kingdom has undertaken a large nuclear power program, the construction of the major proportion of which is the responsibility of the C.E.G.B. Two nuclear power stations were commissioned and are operating successfully. Six others are being built and another is planned. By 1970 it is expected that some 5000 MW of nuclear capacity will be in service out of a total system output capacity of about 67,000 MW in England and Wales. Integrating nuclear plant into the system presents economic, technical, and social problems. Firm decisions on the capacity and location of new generating and main transmission plant have to be made five years before it is required for service taking into account the rate of demand growth, the pattern of demand, system security, and the availability of suitable sites. The economics of individual projects are compared over their useful lives against a postulated background development using the present value concept. (auth)

38476 (A/CONF.28/P/578) CONSTRUCTION EXPERIENCE ON TOKAI ATOMIC POWER STATION. T. Ipponmatsu, T. Yoshioka, and S. Tsujimoto (Japan Atomic Power Co., Tokyo). May 1964. 20p.

Problems encountered and experience gained during the construction works of the station are summarized. Station siting problems, special design features, emergency shut-down devices, the emergency carbon-dioxide injection system, the gas release and partial containment scheme, and construction experiences were described. (auth)

38477 (A/CONF.28/P/585) PHYSICAL STUDIES OF NOVO-VORONEZH ATOMIC POWER STATION REACTOR (WWER). L. V. Komissarov, G. L. Lunin, A. N. Novikov, V. A. Sidorenko, and V. D. Sidorenko (U.S.S.R.). May 1964. 19p.

The power station uses a water-moderated, water-cooled, 760-Mw (thermal) reactor. The results of measurements of reactivity, absorber and control rod efficiencies, criticality, multiplication factor, flux, and bucklings are compared with the calculations, which are outlined. (D.C.W.)

38478 (A/CONF.28/P/594) OPERATIONAL EXPERIENCE ON THE 2ND CHARGE FOR THE HALDEN BOILING HEAVY WATER REACTOR. E. Jamne, J. A. Firing, M. Oevreeide, and T. Wullum (Norway. Institutt for Atomenergi. OECD Halden Reaktor Prosjekt). May 1964. 16p.

An operations summary for HBWR for the second fuel charge up to Jan. 1, 1964 is presented. Heavy water degradation, fission product release due to fuel element failure, plant control and instrumentation, and radiological monitoring in the reactor housing are discussed. (R.E.U)

38479 (A/CONF.28/P/595) WATER CHEMISTRY RESEARCH AT HBWR. L. Hammar, R. Rose, and G. M. Allison (Norway. Institutt for Atomenergi. OECD Halden Reaktor Prosjekt). May 1964. 17p.

The effects of various parameters on the net rate of water decomposition in a boiling heavy water reactor were investigated in the HBWR mainly to establish the feasibility of controlling the water chemistry by addition of deuterium and ammonia to the feed water. A further objective was to study the behavior of the isotope N^{16} in a boiling system. The experiments were carried out at power levels in the range 5 to 18 Mw and at pressures from 10 to 28 atm abs. Under the conditions investigated, the net rate of water decomposition, which was of the order of 5 to 10 ml O_2 (STP) per kg of steam, i.e., smaller than reported for boiling light water reactors, was attributed mainly to radiolytic processes occurring in the boiling channels. Radiolytic equilibrium was attained in the moderator at rather low concentrations of radiolytic gas (about 0.05 ml O_2 per kg D_2O or less) and stripping of this gas from the moderator on passage through the fuel channels by natural circulation gave a relatively small contribution to the net rate of water decomposition. An appreciable influence of parameters affecting the gas stripping efficiency in the fuel channels was observed, indicating a significant recombination of oxygen and deuterium formed in primary radiolytic processes. Thus an increase of the specific net rate of water decomposition (formation of radiolytic gas per kg of condensed steam) was observed with increasing steam production (exit steam quality up to 4%), increasing boiling density (i.e., increasing reactor power at constant steam production) and decreasing pressure (28 to 10 atm abs). In accordance with the observation that, already without any additions to the feed water, radiolytic recombination occurs to an appreciable extent in the fuel channels, a marked reduction of the net rate of radiolysis was obtained with addition of deuterium to the feed water, e.g., from ca. 6 to ca. 0.03 ml O_2 per kg of steam at 10 Mw and 28.5 atm abs. Similar to the observations with no addition to the feed water, the effect of deuterium addition showed a marked dependence on the stripping conditions in the fuel channels. By adding deuterium to give about 0.3 to 0.4 ml D_2 per kg of moderator, the decomposition of ammonia added to the moderator into nitrous and nitric acids is prevented. The radiation stability of the ammonia with respect to decomposition into nitrogen and hydrogen was furthermore found to increase with increasing deuterium concentration in the moderator, in agreement with earlier results obtained at room temperature. Due to the particular design of the primary system, the total concentration of gases which can be maintained in the moderator of the HBWR is rather limited (ca. 5 ml/kg). Because of this limitation, the possibility of producing ammonia in any appreciable concentration in the moderator (e.g., >0.1 ppm) by radiation induced fixation of added nitrogen and deuterium was not feasible. (auth)

38480 (A/CONF.28/P/597) INTRODUCTION OF ROOPPUR NUCLEAR POWER PLANT IN EPWAPDA GRID. Mohammed Yusuf (Pakistan. Atomic Energy Centre, Lahore). May 1964. 16p.

The 70 Mw(e) Rooppur Nuclear Power Plant is scheduled to start commercial operation in the power grid of East Pakistan Water and Power Development Authority (EPWAPDA) in the beginning of 1969. The nuclear reactor of the Plant will be either boiling water or pressurized water type. The EPWAPDA grid is presently under organization and rapid expansion. Four small grids which are at present working as independent systems are scheduled to be interconnected by 1969. The total generating capacity of all these small grids at present is 175 Mw, whereas the total peak demand on them is 110 Mw. This

demand is estimated to grow by 1970 to 440 Mw because of the extensive development program currently in progress in East Pakistan, and the total generating capacity planned to be available at that time in the combined grid is 536 Mw out of which 460 Mw will be firm, so that the 70 Mw Rooppur Plant will constitute about 12 per cent of the total generating capacity in the grid when it will start full commercial operation. The cost of imported fuels in East Pakistan varies from 60 to 80 cents per million Btu. The cost of development of her only hydro potential of 80 Mw was extremely high — $1250 per kw installed. Consequently Rooppur Plant is estimated to produce power cheaper than any conventional plant including hydro. Only gas-fired plants in certain locations of the Province will be an exception. But the Rooppur Plant will serve as base-load station in the EPWAPDA grid in any case, because its cost of incremental power is estimated to be less than that of power from a gas-fired plant. (auth)

38481 (A/CONF.28/P/599) PHYSICS AND ENGINEERING DESIGN OPTIMIZATION OF NUCLEAR POWER PLANT USING GRADIENT METHODS. Barend M. Nel (Union of South Africa. Atomic Energy Board, Pretoria) and Henri Fenech. May 1964. 18p.

The problem of designing an optimum nuclear power plant amounts to the minimization of some objective function, e.g., the function defining the unit cost of electricity in terms of the relevant design variables, subject to a number of constraints. These constraints include the design equations governing the relationship between these variables, the restrictions on the magnitude of some variables, etc. This nonlinear problem can be solved by appropriately modified gradient techniques such as the method of steepest descent, the optimum gradient method, the accelerated optimum gradient method and Newton's method. The application of these methods to the above mentioned problem are described using a specific nuclear power plant as model. Gradient methods generally require an initial design which must satisfy all the constraints; this can be a laborious problem. Procedures are described which will automatically produce such a design from an approximate set of values for the design variables. Two major problems which beset gradient procedures are: (1) errors propagated by the method, and (2) convergence. The first is tied in ultimately with the inversion of matrices of large order. This problem is discussed and illustrated with results obtained for a case problem. Techniques whereby the convergence may be accelerated are described and results obtained by their use given. The problem of trying to establish whether there are several relative minima in the field of interest to designers is mentioned and a technique described which constrains the gradient methods such that they converge to a saddle point, if such a point exists, from which all the surrounding relative minima may be found. A simplified block diagram is included showing the assembly of all the above procedures in a form suitable for coding a digital computer program. The procedures described have been applied to a nuclear power plant involving a total of 63 parameters and 48 constraints and programmed for the IBM 7094 computer. The complete power plant design, including engineering and neutron physics, was considered in order that there may be free interplay between parameters in different sections of the plant, the purpose being to attempt to design an over-all optimum plant rather than an assembly of optimum sections as is often the case. Available results illustrating convergence rates, round-off error in the resulting 48 × 48 matrix, and times for the different operations are given. (T.R.H.)

38482 (A/CONF.28/P/601) THE DON PROJECT. F. Pascual (Spain. Junta de Energia Nuclear, Madrid), L. Palacios, and M. K. Sanders. May 1964. 16p.

The DON Project is dedicated to the development of a heavy water-moderated, organic-cooled system which can operate on natural uranium fuel when built on a large scale. A 30 MWe reactor has been designed to serve as a prototype. Experimental facilities have been incorporated to permit the irradiation of nuclear materials and fuel elements. Isotope production channels have also been included. A Title I design has been completed by the JEN and the American firm, Atomics International. Additional research and development work is also underway where needed. The cool moderator is contained in an aluminum calandria. The hot coolant circulates from a toroidal inlet header through flexible lines to hot pressure tubes located within the calandria tubes. It removes the heat generated in the fuel elements and flows through flexible lines to the toroidal outlet header. The pressure tubes are made of SAP alloy joined to steel and pieces. The fuel element is a 19-rod cluster of UC pellets clad in finned SAP tubes. Control is provided by B_4C rods submerged in the moderator. (T.R.H.)

38483 (A/CONF.28/P/602) MANUFACTURING AND INSTALLATION EXPERIENCE OF THE HEAVY-WATER SYSTEMS OF THE AGESTA NUCLEAR POWER PLANT. P.-I. Nylander, P. Hjertberg, and B. Larson (Allmana Svenska Elektriska A. B., Vasteras, Sweden). May 1964. 15p.

The Ågesta Nuclear Power Plant (R3/Adam), designed for combined district heating and power generation and located 15 miles south of Stockholm, Sweden, went critical on July 17, 1963. The pressurized heavy-water reactor of the pressure-vessel type is fueled with natural uranium. Some of the experience obtained from the design, manufacture, and installation of the components in the main cooling and auxiliary heavy-water systems are presented. (auth)

38484 (A/CONF.28/P/603) THE DESIGN OF THE MARVIKEN BOILING HEAVY WATER REACTOR WITH NUCLEAR SUPERHEAT. P. H. Margen (Aktiebolaget Atomenergi, Stockholm), L. Leine, and R. Nilson. May 1964. 19p.

The second Swedish power reactor, Marviken, was originally intended to be a pressurized heavy water power reactor for 105 Mwe. Studies on larger reactors made during 1961 and 1962, however, suggested that direct cycle boiling heavy water reactors with natural circulation were feasible and that they effected considerable reductions in capital costs due to the entire elimination of the primary cooling circuits with steam generators. It was therefore decided to redesign Marviken as a reactor of this type and to incorporate in addition the possibility of nuclear superheat which had also been studied in some detail. For the new design the output of Marviken was increased to 140 Mwe for saturated steam operation and 200 Mwe with nuclear superheat operation. Manufacture of the pressure vessel started in 1963 and the station is scheduled for commissioning in 1968. The boiling elements consist of Zircaloy-clad UO_2 rod fuel clusters while the first superheater charge is planned with Cr/Ni alloy clad UO_2 rod clusters. The average burnup is currently scheduled for 13,000 Mwd/t-U and the average enrichment of the entire fuel charge with super-heat operation will be about 1.35%. Natural uranium operation is possible with saturated steam. The engineering features include on-load fuelling of the elements for the boiling channels. The containment is of the pressure suppression type with a dry well of

pre-stressed concrete. The turbine has special measures for minimizing leakage. The paper describes the reactor and station and reviews the main development work carried out for Marviken. Reactor operation and safety aspects are also discussed. (T.R.H.)

38485 (A/CONF.28/P/605) A LARGE SWEDISH NUCLEAR POWER STATION WITH A PRESSURIZED HEAVY WATER REACTOR WITH AN OPEN UNIFORM LATTICE CORE. A. Jonsson (Rederi A. B. Nordstjernan. Axel Johnson Institutet for Industriforskning, Nynashamn, Sweden) and B. McHugh. May 1964. 15p.

The work presented here covers a study carried out on a nuclear power plant capable of being built today in Sweden using Swedish resources. The plant is designed in accordance with Swedish practice and with full regard to Swedish conditions, and has a net output of 350 Mw in a one-reactor two-turbine installation. The general plant design resembles closely a PWR type plant in that it utilizes a pressure vessel reactor with multiple steam generator loops feeding the turbine plant with saturated steam. The use of fuel rod clusters in guide tubes or pressure tubes has been avoided by distributing the fuel rods in a uniform lattice over the entire core cross-section. This configuration, which leads to an intimate contact between moderator and coolant gives, in conjunction with the volume ratios dictated by the use of D_2O, many important advantages when compared with all other water reactor cores. A virtual absence of hot channel factors combined with the low form factors inherent in the use of D_2O allows the mean thermal loading of the fuel to be set at a value considerably higher than is normal in water cores. The use of an open core with D_2O also means that there is no practical limitation imposed on the core due to burn-out risks. The physics of the core is such that with UO_2 enriched to 1.5% U-235 in Zr-canning it is possible to achieve a mean discharge burn-up of about 15,000 Mwd/ton U. Operation is possible at a reduced power level with natural UO_2 and in a self-sustaining Pu-recycle mode of operation a burn-up of 9000 Mwd/ton U is possible. (auth)

38486 (A/CONF.28/P/606) STUDIES OF THE FREQUENCY AND POWER REGULATION OF A POWER SYSTEM CONTAINING NUCLEAR AND WATER POWER STATIONS. D. Jungnell and T. Spanne (Sweden. Kungliga Vattenfallsstyrelsen, Stockholm). May 1964. 15p.

The suitability of using pressurized and boiling heavy water reactor plants together with water power plants for frequency regulation in the Swedish network was studied. The Swedish network contains today a total power of about 8000 Mw. The fast load variations are normally not over 1%. In the frequency regulating stations electrical governors with a permanent statism of down to 0.4% are used. Normally the frequency regulation is chosen so that the permanent change in power production will be a little more than 50% of the total power at a frequency change of 1 Hz. Studies of frequency regulation by nuclear power plants were carried out on an analogue computer, for which reason a dynamic model of the power system is developed. The frequency regulating nuclear power stations or the other frequency regulating stations are treated as two separate parts while the remaining part of the power system is represented by a simplified empiric transfer function between power and frequency. As the compensating contribution of the remaining network to the frequency control is small in comparison to the contribution of the frequency regulation stations the accuracy of this model of the remaining network can be considered sufficient. The reactors of the regulating nuclear power stations are assumed to be of the boiling and pressurized heavy water types. For these stations a detailed analogue model is used, including lumped models of the reactor with control system and the steam turbines with valves and control system, so that transients in power, pressure and temperatures in different parts of the reactor system can be studied. The conditions at both regulated and unregulated reactor power at different values of the statism of the turbine governors were studied. Different regulating principles for adjusting the reactor power to the load as well as the influence of transients on the reactor and the main components were investigated. A comparison between nuclear and water power stations used for frequency regulation is made and the cooperation between these stations at various load disturbances is specially considered. (auth)

38487 (A/CONF.28/P/608) FUEL DEVELOPMENT FOR SWEDISH HEAVY WATER REACTORS. H. Mogard, S. Djurle, I. Multer, H. P. Myers, B. Nelson, and U. Runfors (Aktiebolaget Atomenergi, Stockholm). May 1964. 16p.

Recent development work on uranium oxide fuel elements for use in the Swedish heavy water reactors Ågesta and Marviken is reviewed. Development trends for the fuels of possible future heavy water reactor projects are indicated. In comparison with the Ågesta reactor, certain improvements in performance and design are proposed for Marviken which together with progress in fabrication procedure are expected to significantly reduce the fuel costs. The fuel assembly design is characterized by the adoption of long fuel rods and rod spacers constituting a grid. With a slight enrichment of 1.3%, a burn up figure of around 13,000 Mwd/t is foreseen for the Zircaloy-canned boiler fuel elements of the Marviken reactor. Fabrication costs are given. The development program includes in-pile and out-of-pile experiments on prototype fuel elements as well as investigations on some fundamental properties of the uranium oxide fuel and of the Zircaloy canning material. In particular, results of investigations on the heat conductivity and the substoichiometric composition of the uranium dioxide are reported as are also experimental investigations on the hydrogen embrittlement of Zircaloy. Available resources including loop facilities in the Studsvik materials testing reactor R2 are described. In the last year the development work has been largely concerned with superheat fuel elements for possible use in the Marviken reactor and, in particular, with superheat canning materials of Fe–Cr–Ni alloys. Some preliminary data are reported. The fuel development work associated with the long range use of recycled plutonium in the Swedish heavy water reactors is also commented upon. (auth)

38488 (A/CONF.28/P/625) THE PHYSICS OF A STEAM–WATER MIXTURE COOLED HEAVY WATER POWER REACTOR. F. Accinni, R. Bonalumi, C. Bruschi, F. Palazzi, S. Rubbia, and G. B. Zorzoli (Centro Informazioni Studi Esperienze, Milan). May 1964. 16p.

A comprehensive survey is given of the reactor physics work performed at C.I.S.E., within the framework of a power reactor project. These studies were concerned with a natural uranium metal, heavy water moderated, light water-steam mixture cooled reactor. Experimental results and calculated data are described and compared. (T.R.H.)

38489 (A/CONF.28/P/627) ANALYSIS OF INTEGRAL DATA FOR FEW-GROUP PARAMETER EVALUA-

TION OF FAST REACTORS. G. Cecchini, U. Farinelli, A. Gandini, and M. Salvatores (Italy. Comitato Nazionale per l'Energia Nucleare, Rome). May 1964. 20p.

An analysis is made of the applicability of a single few-group cross-section set to a broad range of reactors. This validity is, of course, dependent on the number of groups and for this reason a sixteen group set has been chosen, which represents a sufficiently standard few-group set and is compatible with the maximum number of groups permissible for many one or two dimension diffusion or transport codes. A series of critical facilities are then surveyed and compared with regard to the representation of the spectrum of the reference system in the test region and precision of the measurements. Thermal drivers are compared with fast drivers either for zero flux gradient measurements or for transport measurements which are assumed to be of paramount importance for fast reactor performance evaluation. In the thermal driven facilities, the flux gradient can be achieved either through an internal exponential experiment or by means of transversally finite slab geometry. Finally, a method is described for the reduction of the integral data into few-group parameters starting from an assumed best value set. (auth)

38490 (A/CONF.28/P/636) THE DEVELOPMENT OF NUCLEAR ENERGY IN RELATION TO THE RESOURCES OF NUCLEAR MATERIALS. J. C. van Staveren and J. J. Went (Samenwerkende Electriciteits-Productiebedrijven, N. V., Arnhem, Netherlands). May 1964. 13p.

The material requirements for start up and operation of a future large scale nuclear program of nuclear power plants for electricity production are discussed, using the following assumptions. From 1970–2000 about 50% of the newly installed electric production capacity will be nuclear; the doubling time of the installed capacity will be 12 years in the period 1962–2000; the load factor of the nuclear power stations will be 75%. Using raw nuclear material reserves from estimates of the U.S.A.E.C. and Euratom, the investment and consumption of nuclear materials is discussed for present day power reactors, high conversion reactors and fast or thermal breeder reactors. (auth)

38491 (A/CONF.28/P/664) SOME ENGINEERING STUDIES ON THE ANALYSIS OF KINETICS AND CONTROL OF TOKAI ATOMIC POWER STATION. Junichi Miida (Japan Atomic Energy Research Inst., Tokyo), Nobuhide Suda, Masatoshi Toyoda, Tadashi Kagayama, Atsushi Takeda, and Mitsuru Yoshie. May 1964. 16p.

A series of analyses was made on the kinetics, control, and operational characteristics of the British type gas cooled reactors with positive temperature coefficient of reactivity. The preliminary analyses provided quantitative information on the transient response of the reactors of this type, as well as general conclusions on the stability of reactors with temperature and xenon feedback and the effect of the graphite sleeve on stability. Extensive investigations were made on the xenon-induced, spatial flux oscillations in the radial, azimuthal, and axial directions. It was revealed that the conventional approach to simulate the reactor dynamic behavior was sometimes inadequate. Thus, investigations were made on the space dependent functions of both the nuclear kinetics and the temperature transients. The transfer function representation of the space dependent nuclear kinetics proved to be a convenient means for the control system synthesis described. (auth)

38492 (A/CONF.28/P/672) THE IMPORTANCE OF THE CONVENTIONAL SUPERHEAT IN NUCLEAR POWER STATIONS IN THE COMING DECADES. S. Andrzejewski (Warsaw. Technical Univ.). May 1964. 8p.

It could be stated that in the next decades the nuclear power stations will be constructed simultaneously with the classical power stations. The studies and calculations have demonstrated that, until the technology of high temperature reactors will be completely solved, it will be more economical to construct combined power stations in which heat from the reactor will serve only to evaporate water, and fossil fuel will be used to superheat the steam. In this case reactors could be constructed for medium temperatures. The studies of the availability of different types of the reactors have proved, that only the medium temperature reactors are in the present time really available. It is well known that pressurized water reactors and boiling water reactors can work with the simple superheat. It is shown that the boiling water graphite reactors and the reactors cooled by organic liquid or by gas can also economically work in the scheme of superheat and reheat. The conception of the graphite moderated, carbon dioxide cooled Magnox type reactor in the scheme of supercritical pressure and double reheat was analyzed. In this scheme the reactor heat exchanger produces supercritical steam of the main turbine. There exists a second separate low pressure circuit for the auxiliary propulsion (carbon dioxide blowers and feed pumps). The influence of the superheat on the cost of the turbosets is analyzed. The preliminary design and calculations have proved, that incremental power done by superheating is cheaper than in the conventional power stations and the efficiency of the fuel burning is better. It is concluded that if the nuclear and classical power stations are constructed simultaneously in any country, the best economical solution in the next decade might be the construction of combined nuclear–conventional power stations, i.e., nuclear steam generator with the conventional superheat. (auth)

38493 (A/CONF.28/P/679) EXPERIENCE FROM THE COMMISSIONING, THE CRITICALITY EXPERIMENTS AND THE POWER OPERATION OF THE AGESTA NUCLEAR POWER PLANT. N. Rydell (Aktiebolaget Atomenergi, Stockholm), P. Blomberg, and E. Ericsson. May 1964. 15p.

Programs of and experiments from the three major phases in the commissioning of the Ågesta Nuclear Power Plant are presented. (auth)

38494 (A/CONF.28/P/682) REACTOR PHYSICS STUDIES AND COMPARISONS BETWEEN REACTOR PHYSICS DATA FROM CALCULATIONS AND MOCK-UP STUDIES AND FROM MEASUREMENTS IN THE AGESTA NUCLEAR POWER PLANT. G. Apelqvist (Sweden. Kungliga Vattenfallsstyrelsen, Stockholm), P. E. Blomberg, O. Nylund, and R. Persson. May 1964. 15p.

At the time when the Ågesta reactor was designed, the only direct experimental information of relevant reactor physics data available was obtained from exponential measurements. The calculations were based on diffusion theory and four-factor formalism. Complementary data have since been produced by new experimental facilities and calculational methods. The 19-rod clusters were investigated in exponential and critical assemblies both in Sweden and at the Savannah River Laboratory in USA. The buckling was measured as a function of pitch, internal spacing in the cluster, and temperature. Void effects were also studied and intercell flux measurements made. The results of these measurements did not cause any appreciable change of the calculated neutron economy and hence of the design. In the

Ågesta reactor itself critical water levels were determined with three core sizes, with and without control rods. Bucklings and reflector savings were obtained from copper wire activations, and the reactivity loss due to temperature increase was measured up to 215°C with control rods in the core. Microscopic properties in the lattice cell were investigated by means of activation techniques. The studies included determinations of neutron spectrum parameters, the initial conversion ratio, disadvantage factors, and the flux peaking in the fuel pin connections. The control rod worth and their influence on the power distribution have been calculated with homogeneous and heterogeneous methods. The extensive series of control rod measurements, both in critical and exponential assemblies and in the power reactor itself, served as a good base for correlation with the theory. The reactivity worths were obtained from measurements of bucklings and reactivity water-level coefficients, and from neutron pulse decay curves. The perturbation of the power distribution due to control rods was studied by activation techniques and movable detectors. Dynamic characteristics are to be studied as a function of power level and burn-up by oscillatory perturbations and by noise analysis. Time constants and reactivity coefficients will be obtained by fitting an analogue model to the measured transfer functions. A thorough preparation has been made for investigating the burn-up effects in the fuel elements, of which a representative set of pins have been intercalibrated with the pile-oscillation technique. The changes of the excess reactivity and the neutron spectrum parameters in the fuel, as a function of the neutron dose, are to be included in the studies of the burn-up effect. (auth)

38495 (A/CONF.28/P/683) THEORY AND APPLICATIONS OF HETEROGENEOUS METHODS FOR HEAVY WATER REACTOR CALCULATIONS. A. Jonsson (Aktiebolaget Atomenergi, Stockholm), G. Naeslund, T. Skardhamar, P.-E. Ahlstroem, and P. Lindgren. May 1964. 16p.

Commonly used methods for overall reactor calculations of reactivity and flux distributions assume that the reactor media can be considered as homogeneous. For defective or composite lattices containing for example vacant positions, fuel elements of different types or control rods, or if the number of elements is less than 20–30, homogeneous theory may apply less well. To handle these cases a series of heterogeneous computer programs were developed. Comparisons with experiments have given some confidence in these methods for treating uniform as well as non-uniform heavy water lattices. The experience and present status of the work are summarized, and the way in which the heterogeneous method was adapted to heavy water power reactor calculations is described. (auth)

38496 (A/CONF.28/P/687) ON THE STABILITY OF STEAM-COOLED FAST REACTORS WITH CERAMIC FUEL. P. Schmid (Switzerland. Eidgenössisches Institut für Reaktorforschung, Würenlingen). May 1964. 16p.

By virtue of their short generation times fast reactors may be considered as particularly safe, provided that their reactivity feedback is governed by a prompt negative contribution from effects inherent to the system. In large ceramic fueled reactors this is to be ensured by the Doppler coefficient of reactivity. It is generally known that stability may be jeopardized by sufficiently large delayed contributions of either sign to the total reactivity feedback. Nevertheless one has to cope with the fact that uranium-plutonium oxide fueled fast breeder reactors with core volumes larger than a few hundred liters exhibit sizable positive void coefficients if they are cooled by steam. Stability criteria are derived which allow to determine the maximum permissible ratio of magnitudes of the positive steam void coefficient and the negative Doppler coefficient of reactivity. Two models are considered, according to the types of instability to be prevented. (auth)

38497 (A/CONF.28/P/692) THE LUCENS EXPERIMENTAL NUCLEAR POWER STATION. Pierre Krafft (Atomelektra A. G., Zurich). May 1964. 15p.

The Lucens reactor is described. The prototype of a pressure-tube, heavy water-moderated power plant is cooled by CO_2 and fueled by magnesium alloy-clad slightly enriched metallic uranium. Predicted costs and stage of construction are reviewed. (R.E.U.)

38498 (A/CONF.28/P/693) THERMAL PROBLEMS OF GAS-COOLED REACTORS FOR MAGNETOHYDRODYNAMIC POWER GENERATION. L. S. Dzung (Brown, Boveri and Co. Ltd., Baden, Switzerland). May 1964. 12p.

Recent developments of magnetohydrodynamic (MHD) generators for large power production trend toward utilizing the possibility of inequilibrium non-thermal ionization for increasing the electron temperature over gas temperature thus enhancing the electric conductivity of the flowing gaseous medium. Since the molecules of polyatomic gases possess internal degrees of freedom in addition to translational ones, they tend to absorb the excess energy of the electrons, thus only monoatomic gases in close circuit are suitable for electron temperature enhancement. A high temperature reactor, cooled by the monoatomic gas used as the flow medium for the MHD generator, is therefore the immediate choice. Such a reactor presents stringent thermal design problems due to the requirement of intensive heat transfer and of moderate frictional power loss. These problems are discussed, and methods of their solution given. It is shown that the ratio of frictional power loss to the heat rate and the ratio of the reactor core length to reactor core diameter are both related to the volumetric power density and to a linear dimension chosen as a characteristic length of the cooling matrix. A method is developed to take care of the large change of gas density during the passage through the reactor core. The difficulty of fulfilling the conditions imposed by the requirements of these quantities increases usually with the size of the reactor. It is also shown that the requirements of the reactor and those of the MHD generator may dictate quite different choices of the most suitable gas medium. (auth)

38499 (A/CONF.28/P/694) GAS COOLING FOR FAST REACTORS. P. Fortescue, R. Shanstrom, L. Meyer, W. Simon, and P. Fischer (General Atomic Europe, Zurich). May 1964. 16p.

Investigation of the possibilities of gas cooling for fast-breeder power reactors, including design work on a 1250 Mw(t) plutonium-fueled reactor of this type has been carried out at Zurich during the years 1962–1963. Interest in gas cooling for this purpose, apart from the desirability of having an alternate technology for fast reactors avoiding, as yet, unresolved practical engineering and operational difficulties of liquid metals, results from the possibilities for both improved fast reactor core neutronic performance and simplified engineering and operational features. Core physics studies have shown coolant reactivity effects which are an order of magnitude smaller than for liquid metal cooled systems. This facilitates core designs with unity internal conversion ratio, while avoiding undesirably high positive coolant void and temperature coefficients and permits design for long intervals between refuelings. Fast spectrum calculations have been performed with the new

GAM II code utilizing 99 fine group cross sections for a range of volumes and compositions. Other results of these calculations show a harder neutron spectrum for gas cooled core designs resulting in an increase of breeding ratio of 0.15 to 0.20 over that with sodium cooled cores. The results of design studies are presented, including results which show that for cores in the 1,000 Mw(t) range, ratings in the region of 0.7 Mw/kg fissile, together with power densities of the order of 250 Kw/litre are readily obtainable, with helium or CO_2 cooling, at ambient pressures of 68 atmospheres for total pumping power expenditures of no more than 3% of the thermal output. Investigation of alternate fuels for the system has been made with particular attention given to use of simple, round, stainless steel clad, oxide fuel elements with special design features to accommodate fission gas release for burnups in the 100,000 Mwd/t range. Operating conditions are substantially similar to present projected liquid metal-cooled designs and with maximum fuel element ratings in the 500 to 650 watt/cm range. Surface roughening of the fuel element cladding is employed in a new, optimized way resulting in reducing the required number of fuel elements by a factor of four, while, at the same time, increasing the core specific power and power density. A new core thermal design code, GAZELLE III, which optimizes surface roughening, was developed to obtain this result. The use of resonance absorbers, mixed with the core structural material to secure continuous decrease in reactivity with increase of water content, has been studied as a means of dealing with steam-in-leak, and allowing use of water injection for emergency cooling. Detailed neutron spectrum calculations and reactivity determinations have been made for resonance absorbers including indium for a range of fast to soft spectrums. Appropriate resonance absorbers have small effect on the breeding ratio under operating conditions. A layout has been made of a 500 Mw(e) power system incorporating a prestressed concrete pressure vessel enclosing the reactor core, series steam turbine driven circulators, and steam generators capable of supplying 565°C steam. Special features are incorporated in the concrete vessel concept to require two independent failures before rapid loss of coolant. Over-all plant efficiency is about 38%, taking into account coolant pumping requirements. (auth)

38500 (A/CONF.28/P/696) SPECIAL PROBLEMS RELATING TO MONOTUBE BOILERS IN NUCLEAR POWER STATIONS. J. Kaegi and P. Doroszlai (Sulzer Bros., Ltd., Winterthur, Switzerland). May 1964. 16p.

With the aid of various examples of application in the field of gas-cooled reactors a few specific problems are taken and dealt with in the light of the experience obtained from conventional steam boiler construction as well as taking into account tests and studies which have been carried out. The dynamic problems can be divided into two groups, i.e., one group dealing with the major disturbances which occur under special operating conditions and the other group relating to small disturbances as occur during the control procedure under normal operation. (auth)

38501 (A/CONF.28/P/697) AN ANALOGICAL STUDY OF THE DYNAMIC BEHAVIOR OF THE LUCENS EXPERIMENTAL NUCLEAR POWER STATION. J. R. Gilbert, Y. Fishman, P. Doroszlai, and E. Buehler (Therm-Atom A. G., Winterthur, Switzerland). May 1964. 14p.

The behavior of the Lucens station under variable conditions has been studied on a large-capacity analog computer. The object of this work was to analyze the operation of the plant, to check its stability, to compare various modes of operation as well as different control systems, and finally to select the coefficients giving optimum performance. It is confirmed that the station is capable of reacting rapidly to changes in the conditions demanded, and that the fluctuations of the controlled values remain within acceptable limits. In particular the gas temperature at the reactor outlet varies little, and the frequency variations observed in the isolated station are small. (auth)

38502 (A/CONF.28/P/711) HEAVY-WATER-MODERATED, ORGANIC-COOLED LATTICE INVESTIGATIONS EXPERIMENTAL RESULTS AND COMPARISON WITH THEORY. C. F. Hoejerup, O. Kalnaes, H. Neltrup, and P. L. Oelgaard (Denmark. Atomenergikommissionen. Forsoginstitut, Riso). May 1964. 16p.

As part of the studies of the heavy-water-moderated, organic-cooled reactor concept, DOR, carried out at the Research Establishment Risö, a series of reactor-physics measurements on this type of core lattice was performed in the exponential facility EXPO. The measurements included determination of material buckling, fine-structure flux distribution, neutron temperature, Westcott r-factor, and overall temperature coefficient of the material buckling. The fuel elements used were cluster-type elements containing 19 fuel rods (12.7 mm diameter), clad in 1 mm thick aluminum tubes. As fuel both natural uranium metal and natural uranium dioxide were employed, and as coolant Diphyl (or Dowtherm A) and air were used. The investigations included fuel elements surrounded by an aluminum pressure tube only as well as elements with an additional aluminum calandria tube. The lattice pitch was varied in each series of measurements. This variation covered the range from 6 to 57 of the heavy-water to fuel volume ratio. The results obtained so far for DOR-type lattices in the EXPO facility, including measurements on lattices in which the organic coolant was replaced by air are reported. A short description of the experimental techniques used in obtaining the results is given. (auth)

38503 (A/CONF.28/P/715) THE CONTRIBUTION OF NUCLEAR ENERGY TO THE SOLUTION OF THE ARGENTINE ENERGY PROBLEM. J. L. Alegria, B. J. Csik, E. V. Nasjleti, C. C. Papadopulos, and O. A. Quihillalt (Argentina. Comision Nacional de Energia Atomica, Buenos Aires). May 1964. 16p.

An outline is presented of the general characteristics of the Argentine Republic and its present energetic situation. The energy resources, power availability, and electric power demand, both present and estimated for the future, are specially discussed. A brief outline of the country's nuclear stand is offered. After stating the Argentine energetic problem, possible alternative solutions are discussed, considering their respective advantages and disadvantages. The possible contribution of nuclear energy is dealt with in further detail. The financing aspects are specially analyzed, because of their fundamental importance for a developing country. Finally a discussion is given of all the factors and criteria utilized in selecting the type, power, and location of the first nuclear power station to be installed in Argentina. (auth)

38504 (A/CONF.28/P/728) EXPERIENCES ON THE DESIGN, CALCULATION AND THE MANUFACTURE FOR POWER REACTOR COMPONENTS. K. J. de Jong, C. de Pater, and M. C. van Veen (Neratoom, N. V., The Hague). May 1964. 18p.

Descriptions are given of components for the power stations SENN, KRB, and SEP, which are of the boiling water type, designed by the U. S. General Electric Co. Based on functional specifications, stress analysis and heat transfer

calculations were prepared and the design made for the secondary steam generators for SENN. Similar work will be carried out for the reactor pressure vessel for the 50-Mw(e) SEP power station. The core structures for the SENN and KRB power stations were and, respectively, will be manufactured to construction drawings provided by the client. Extensive calculations are reported describing the dynamic behavior of the SENN steam generators. The severe manufacturing and control requirements and the way in which these were realized are described. Methods applied to realize the high dimensional accuracy required in the specification for the core structures are described. The influence of the pressure vessel codes ruling in different countries is discussed. As these requirements for calculation and control sometimes are insufficiently defined and sometimes fail completely, a matter of difference may be created. Two possibilities of manufacturing reactor pressure vessels, viz., the application of forged rings, and the application of rolled and bent plates, are discussed. (auth)

38505 (A/CONF.28/P/731) ANALYSIS OF THE TECHNICAL AND ECONOMICAL ASPECTS OF THE INCLUSION OF A NUCLEAR POWER STATION IN ELECTRIC NETWORK OF VARIOUS SIZES FOR SELF-PRODUCERS OR NATIONAL DISTRIBUTION. S. Pittori (Italy. Comitato Nazionale per l'Energia Nucleare, Rome), C. Del Tredici, D. Dini, G. Mussari, L. Orsoni, L. Biondi, and A. Vaudo. May 1964. 16p.

The technical and economic aspects of the problem concerning the inclusion of nuclear stations into a vast national power network are examined. The possible characteristics of a power network serving a number of companies which produce power for their own use with particular regard to the geographical distribution of use and production, seasonal, weekly, and daily load diagrams, interchanges with external networks, etc., are considered. (auth)

38506 (A/CONF.28/P/736) CHEMICAL AND RADIOCHEMICAL ASPECTS OF THE ITALIAN NUCLEAR POWER PLANTS IN OPERATION. C. della Rocca, R. Gasparini, M. Imbergamo, and P. Sturla (Italy. Ente Nazionale per l'Energia Elettrica, Rome). May 1964. 20p.

Particular technical characteristics of SENN, such as the use of Monel in the primary circuit (steam generators), which makes the data collected on radioactive crud particularly interesting, are considered. The special start-up procedures adopted have allowed the primary circuit crud to be studied for the first time in a BWR station. Chemical and radiochemical data obtained during start-up and initial operation on core integrity, steam drum decontamination factors, stack release activity, fission products in the primary water and stack release, primary water and feedwater chemistry are also given. These data are supplemented with information on the operation of reactor clean-up, condensate demineralizer, radwaste and defective fuel detection systems. Information on the chemical control of CO_2 during start-up and initial operation of SIMEA is provided, with specific reference to carbon oxide concentrations. The concentration of carbon oxide at equilibrium, as an indication of the degree of corrosion and graphite quality, is compared with data relating to similar plants. A brief mention is made of the analytical methods perfected for the determination of impurities in the CO_2, as well as the performance of the CO_2 generating plant. Problems arising from the use of a special coating compound during erection for the preservation of the primary circuit metal parts are illustrated. Chemical problems encountered at SELNI are considered, as well as their influence on the choice of chemical treatment for the main cooling system. Details are provided on the chemical treatment system of this station, which is planned to operate under chemical shimming. (D.E.B.)

38507 (A/CONF.28/P/737) GARIGLIANO NUCLEAR POWER PLANT. R. Lepore, U. Belelli, M. Mirone, and F. Velona (Societa Elettronucleare Nazionale, Rome). May 1964. 17p.

The Garigliano station represents one of the first experiences of European utilities in the construction of a large nuclear power plant. The major problems encountered at the various stages of plant construction and start-up are summarized, comments on the economics are provided, and the main results of the tests performed at startup are illustrated. (auth)

38508 (A/CONF.28/P/745) TARAPUR ATOMIC POWER STATION. M. N. Chakravarti and M. R. Srinivasan (India. Dept. of Atomic Energy, New Delhi). May 1964. 14p.

The Tarapur Atomic Power Project is described. The station is located about 62 miles north of Bombay and will feed power into the power systems of Western India serving industrial areas around Bombay and in Gujarat. The reasons for adopting the dual reactor design and the choice of the output of the station are dealt with. The choice of the reactor type and the constructor was made from among seven proposals received from four countries, submitted in response to a global invitation to bid, which included detailed performance requirements and also standards for design and workmanship. The station will consist of two boiling water reactors using forced circulation with internal steam separation and pressure suppression containment. The philosophy of the layout and the basis of design of the systems and components and how this was influenced by conditions at the site, characteristics of the power system into which the station will be feeding power, and the fact that two identical reactors are housed together are discussed. The reasons that led to the choice of the core design, which consists of slightly enriched uranium oxide pellets clad in Zircaloy-2 arranged in a 6×6 matrix, is dealt with. Information about the cost of the station and power costs is also presented. (auth)

38509 (A/CONF.28/P/746) INTEGRATION OF NUCLEAR POWER STATIONS IN POWER NETWORKS WITH SPECIAL REFERENCE TO THE DEVELOPING COUNTRIES. M. Dayal (India. Dept. of Atomic Energy, Bombay). May 1964. 17p.

A discussion is presented of the various factors that have to be taken into account in deciding the role of atomic power in a power system such as size of system and units, availability factor, system load factor, storage hydro availability, operating costs, etc. The general problem of operating nuclear power stations in a power system consisting of hydro, thermal and nuclear stations is considered. The installation of sequences of nuclear and conventional power stations, and the economics of the system as a whole, are examined; the relative roles of various types of stations in meeting the load and energy requirements, both present and future, are investigated. The applicability of these methods of examination to the special problems of developing countries is examined. The costs of nuclear and conventional stations in India are examined from the system point of view and cost comparisons between sequences of nuclear and conventional power stations discussed. Three specific power systems in India are considered in detail. These are the Western regional

system, the Northern system, and the Southern region system. In these areas nuclear power stations aggregating 1.2 million kilowatts are to be installed by 1971. Examination reveals that these nuclear stations and others to be built thereafter could take the future base load in these regions and also part of the energy requirements at lower plant factors and that maximum economies would be achieved for the systems by the installation of progressively increasing amounts of nuclear power. Criteria are derived which can be used, particularly by the developing countries, in studying the introduction and the future role of nuclear power in power networks. (auth)

38510 (A/CONF.28/P/770) CONTRIBUTION OF THE ARDENNES NUCLEAR POWER PLANT IN THE DESIGN AND MANUFACTURE OF EQUIPMENT FOR NUCLEAR REACTORS. P. Klees and Ch. Gerard (Ateliers de Constructions Electriques de Charleroi. Division Nucleaire, Belgium). May 1964. 19p.

On the basis of the experience accumulated during the Ardennes Power Plant construction, the progress made by the manufacturing industry in the refinement of fabrication procedures is outlined. (auth)

38511 (A/CONF.28/P/776) THE OPTIMUM REACTIVITY CONTROL OF A MULTIZONE NUCLEAR REACTOR WITH RESPECT TO THE MAXIMUM OUTPUT OF THE POWER STATION. J. Schmid and V. Stach (Československá Akademie Věd. Ustav Jaderného Vyzkumu, Řež). May 1964. 20p.

The conditions for minimizing the power losses resulting from absorption rods to control excess reactivity in power plants with continuous refueling are determined in calculations for a heavy-water, gas-cooled reactor. Relations for determining the thermal output of a channel as a function of the insertion depth of the neighboring absorption rod are obtained, together with relations for determining the effect of compensating rods on electrical and thermal output for both controlled and uncontrolled gas flow in individual channels. Functions are developed for determining the optimum insertion depth of the absorption rods and the optimum rod insertion sequence. (D.C.W.)

38512 (A/CONF.28/P/777) DESIGN PROBLEMS IN THE D_2O-MODERATED, ORGANIC-COOLED REACTOR CONCEPT DOR. M. Moeller-Madsen, F. List (Denmark. Atomenergikommissionen. Forsøginstitut, Risø), and J. Elming. May 1964. 13p.

A feasibility study of a heavy-water-moderated, organic-cooled power reactor called DOR is being carried out by the Danish Atomic Energy Commission at the Research Establishment Risö. The aims of the feasibility study are summarized, and a description of the mechanical design of DOR is given. The heavy-water moderator is contained in a calandria tank, and hot pressure tubes containing fuel elements and coolant run vertically through the calandria tank. As fuel, UO_2 and UC clad with SAP are considered. SAP material is used for the coolant pressure tubes through the core. Stainless steel is used for the calandria tank, which has Zircaloy tubes rolled into the top and the bottom tube plate. DOR is designed for an output of about 250 Mw(e). The mechanical design of coolant tubes, fuel elements, and calandria tank is considered to present some of the major problems in the DOR project; therefore, efforts have largely been concentrated on the development of these components. Under research and development contracts, Danish industrial companies are participating in this development work. The present design of the components mentioned is discussed. A survey of experimental work, which has been carried out, is given. The experiments are related to coolant channels and calandria tank and comprise experiments with rolled joints between SAP and stainless steel, and between Zircaloy and stainless steel. Experimental investigations of the stiffness of calandria tube plates and of coolant pressure drop across the core are described. An account is given of experimental work, which is at the preparatory stage. These experiments are concerned with an out-of-pile loop with a DOR coolant channel in full size, an out-of-pile facility for the investigation of heat transmission with electrically heated dummy fuel elements, an organic in-pile loop, and test sections of the calandria tank. (auth)

38513 (A/CONF.28/P/778) POTENTIALITIES OF HEAVY-WATER-MODERATED GAS COOLED PRESSURE TUBE REACTORS. Wolfgang Keller (Siemens-Schuckertwerke A. G., Erlangen, Germany). 1964. 19p.

The advantages of CO_2 as coolant for heavy water reactors are indicated; and the merits of some fuel-cladding systems for such reactors are discussed, with comparison of burnup and plutonium production for various fuel elements. The reactor design (vertical pressure tubes) preferred by the AKB is discussed, including efficiency and coolant system design. The economic potential of heavy-water, pressure-tube reactors is considered, with estimates of fuel and power costs. (D.C.W.)

38514 (A/CONF.28/P/779) OBJECTIVES IN THE DEVELOPMENT OF D_2O PRESSURE VESSEL REACTORS. Albert Ziegler (Siemens-Schuckertwerke A. G., Erlangen, Germany). May 1964. 19p.

The fundamental reason for the development of heavy water moderated reactors for power production is their superior neutron economy. From an economic viewpoint it is examined how much lower the fuel costs are than in the case of enriched fuel. The capital investment for D_2O and a fuel load are compared with the cost of a core load for light water reactors. With regard to larger units, it is discussed how much investment and operating costs are likely to exceed those of light water reactors. The main obstacle for the furhter development was generally seen in the limitation of power imposed by the restricted size of the pressure vessel. How far the upper limit for the power can be raised by developing a pressure vessel made of prestressed concrete is examined. By enlarging the vessel it is possible to reduce the neutron leakage to such an extent that, with thorium–uranium-233 fuel, a conversion factor above one can be obtained. The breeding gain will be sufficient to maintain by reprocessing, after a burnup of about 30000 Mwd/t, a constant reactivity of the reactor. The breeding cycle can also be initiated with uranium-235 or technical plutonium. It offers, under certain conditions, economic aspects for the utilization of plutonium as favorable as those of a fast breeder fueled with oxide. How far the investment costs may be reduced by the admission of boiling with subsequent nuclear superheating is discussed. As a first step in this direction the MZFR is now being equipped with loops for boiling and superheating experiments. (auth)

38515 (A/CONF.28/P/809) DESIGN, DEVELOPMENT AND MANUFACTURE OF CONTROL ROD DRIVES FOR HEAVY WATER POWER REACTORS. S. Ericsson and B. Ahlnaes (Allmanna Svenska Elektriska A. B., Västerås, Sweden). May 1964. 14p.

A description is given of the experience which has been gained in the Swedish work on D_2O-moderated and -cooled pressure vessel reactors, one being the Ågesta reactor, which is now in operation, and the other the Marviken re-

actor, which is in an advanced design stage and is due to be critical in 1968. In both reactors the absorber rods are tubular, and the absorbing Cd–In–Ag alloy is canned on the inside and outside with stainless steel. In the boundary region the absorbing alloy and the canning material are metallurgically bonded to each other. The development and the manufacture of the control rods is discussed. The drive mechanisms are of the same principal design in Ågesta and Marviken. The differences in location and environment conditions, however, make a number of modifications necessary for Marviken. A description is given of the design of the drive mechanisms, of the results from the extensive development work which was performed for Ågesta, and of the planned prototype tests for Marviken. Finally, some conceivable types of control rod drives for developed heavy water power reactors are mentioned, particularly a drive for location below the reactor core in the pressure vessel bottom. (auth)

38516 (A/CONF.28/P/810) DESIGN AND MANUFACTURE OF THE REACTOR PRESSURE VESSELS FOR THE ÅGESTA AND MARVIKEN POWER STATIONS AND SOME FUTURE DEVELOPMENTS. Olof Hellstroem (Uddeholms A. B. Degerfors Järnverk, Sweden). May 1964. 15p.

The design and manufacture of the pressure vessels for the Ågesta (homogenized, heavy-water reactor) power station and the Marviken (natural-circulation, direct-cycle, boiling-heavy-water reactor with superheat facilities) power station are discussed, including design bases and special calculations, design features, materials, and manufacturing techniques. A proposed pressure vessel design is also described. (D.C.W.)

38517 (A/CONF.28/A/824) LES CENTRALES NUCLEAIRES UTILISEES AUX FINS DE DESSALEMENT DE L'EAU ET DE LA PRODUCTION DE L'ELECTRICITE; LEUR PERSPECTIVES DANS LES REGIONS ARIDES ET SEMI-ARIDES. (Nuclear Plants for Power and Saline Water Conversion; Their Prospects in Arid and Semi-Arid Regions). M. Chine and M. Baklouti (Tunisia. Commissariat à l'Énergie Atomique, Tunis). May 1964. 8p.

Water requirements of industrial and domestic purposes are increasing, and in several cases water supply of these regions by pipes is not the best solution; then, water conversion plants are to be considered among alternative water supply systems. Among energy sources required for water conversion plants, nuclear energy may be considered. Nuclear energy may offer advantages especially for dual purpose plant. Many problems of course have to be solved but reactors and saline water conversion plants technology at present time has no great difficulties to be solved. Generally, it is possible to foresee types of reactors to be adapted for dual-purpose, processes for desalination which have the great experience, and the problems of connection of energy source and desalination plant. Some situations and especially that of Tunisia will be examined. (auth)

38518 (A/CONF.28/P/833) THE METHOD OF MAIN PARAMETER DETERMINATION OF HEAVY-WATER GAS-COOLED POWER REACTOR CORE. J. Markvart, J. Pfann, and P. Sulc (Ceskoslovenska Akademie Ved. Ustav Jaderneho Vyzkumu, Rez). May 1964. 17p.

The method and results of optimization calculations of heavy water power reactor core parameters are described. The method is based on the complex optimization of parameters from the point of view of main technical and economic indexes of an industrial power station. Direct application of final optimization criteria concerning the whole power station in concrete applications restricts the choice of sufficient number of independent variable parameters of reactors, primary and secondary circuits. The analysis of general relations for useful power and net efficiency of the power plant leads to the determination of objective partial criteria for optimization of some active zone parameters. In many cases these criteria facilitate the judgement of specific problems connected with the design of the reactor. (auth)

38519 (A/CONF.28/P/859) IN-CORE INSTRUMENT DEVELOPMENT IN THE HBWR PROGRAMME. B. Aarset, H. P. Olson, R. D. Smith, and O. Vapaavuori (Norway. Institutt for Atomenergi. OECD Halden Reaktor Prosjekt). May 1964. 20p.

The development of fuel channel flow and void measuring turbines, dynamic void gauges, heat flux measurement and boiling channel power measuring devices was initiated to support the experimental dynamics research program at HBWR by permitting continuous dynamic measurement and comparison of in-core parameters during perturbation experiments. With successful long-term performance of this type of device, in-pile, the instrument development program was diverted towards in-core protection and measuring devices for high-powered test fuel elements operating at real heat-transfer limits. Devices in this category which have been or are being evaluated with test fuel channels are: the burnout detector, the gamma thermometer, central oxide thermocouples, and instability monitoring. In new dynamics investigations at HBWR in-pile channel flow perturbation devices will be tested in association with short-time-constant instrumented tubular metallic fuel assemblies. In the process of testing past instrumented fuel assemblies, natural circulation steady-state hydraulics measurements were made parametric in pressure, channel power, subcooling and axial flux shape and differences from both calculations and prediction from electrical loop data were observed. (auth)

38520 (A/CONF.28/P/860) DYNAMICS OF BOILING HEAVY WATER REACTORS BASED ON HBWR RESEARCH PROGRAMME. H. Ager-Hanssen, T. Eurola, Y. Fishman, and J. E. Lunde (Norway. Institutt for Atomenergi. OECD Halden Reaktor Prosjekt). May 1964. 17p.

In the period from 1960 to 1963 extensive reactor statics and dynamics investigations have been conducted at HBWR to develop models describing the behavior of natural circulation boiling D_2O reactors. The two fuel charges used in these investigations are: a low-power density aluminum-clad, natural metallic uranium fuel charge and a high-power density, Zircaloy-clad, 1.5% enriched uranium oxide charge. The necessary equipment and experimental techniques for obtaining reactor transfer functions were developed and successfully employed in the dynamics program performed with the metallic fuel charge. To permit simultaneous analysis of the time behavior of a large number of in-core signals in the dynamic program with the oxide fuel charge, an extensive system for automatic data reduction was developed. From the dynamics investigations carried out, it can be concluded that the models previously developed for natural circulation light water boiling reactor stability predictions are not applicable to a natural circulation heavy water boiling reactor. While in the light water boiling reactor dynamic model the entire core is usually considered as a single upcoming boiling channel, with the downcomer in the reflector, there is only a very weak hydraulic coupling between the various channels of a heavy water boiling reactor. This difference between light and heavy water boiling reactors makes it possible to achieve higher coolant power densities stably in D_2O reactors than in H_2O reactors. (auth)

38521 (A/CONF.28/P/863) THE INCORPORATION OF NUCLEAR ENERGY INTO THE SPANISH GRID. F. Pascual (Spain. Junta de Energia Nuclear, Madrid), and J. Molina. May 1964. 18p.

Spain is subjected to a fast rate of increase in electrical energy consumption, which has doubled in the last seven years. The hydroelectrical resources, today representing 75% of the total production, have progressively been depleted. Domestic fossil fuels are costly and their production is insufficient to cover the needs of electrical energy production through thermal stations. Imported fuel is needed, generally crude oil, to fill in the gap. With this situation as a basis, the incorporation of nuclear stations in the Spanish electrical system has been studied, taking into account, especially, the competition with thermal stations which burn imported fossil fuels. In this study the structure of the Spanish electrical network is considered, especially with reference to the size of the nuclear stations and their utilization factor. The program of installation of nuclear power plants in Spain is indicated based on the applications submitted by the utilities and the general lines established by the Government. The necessary investment and the possible participation of Spanish industry are also analyzed. (auth)

38522 (A/CONF.28/P/865) LATINA NUCLEAR POWER STATION: COMMISSIONING AND FIRST OPERATIONAL EXPERIENCE. A. Bertini (Italy. Ente Nazionale per l'Energia Elettrica, Rome), G. Gualtieri, G. Lesnoni, B. Zaffiro, M. Calcagno, and R. Negrini. May 1964. 19p.

Tests carried out during reactor commissioning and the subsequent operational measurements and analyses relevant to the safety and efficiency of the Latina reactor are described. (auth)

38523 (A/CONF.28/P/866) THE POWER OUTLOOK IN AUSTRALIA. (Australia. Atomic Energy Commission). May 1964. 18p.

Existing electricity generating and transmission arrangements are described and demand and demand growth, present and future (to 1975), are summarized. Fuel resources, problems of particular States, current trends in collaboration between states for electricity generation and supply purposes and the outlook for the use of black and brown coal, oil, hydro, natural gas, nuclear and tidal power are mentioned. It is suggested that, in the larger electrical systems in Australia utilizing relatively cheap and abundant sources of black and brown coal, there is little likelihood of nuclear power being introduced within the period under review. In some of the smaller systems, in particular South Australia, indigenous fuel is less abundant or wholly committed, and fuel must be imported. In these circumstances nuclear power could be competitive. However, these systems are not yet sufficiently developed — individual system demand being below 500 Mw — to enable nuclear units in the larger, less costly range to be introduced immediately. Nevertheless, considering current trends in nuclear power developments and costs, it is possible that nuclear units of the order of 200 Mw capacity could be introduced within the period under review. (auth)

38524 (A/CONF.28/P/872) THE ITALIAN ORGANIC REACTOR PROGRAM: PRESENTATION OF THE REACTOR DESIGN AND OF THE ORIGINAL SOLUTIONS GIVEN TO SOME OF THE PROBLEMS PECULIAR TO THIS TYPE OF REACTOR. F. Cesari (Italy. Comitato Nazionale per l'Energia Nucleare, Rome), R. Di Menza, E. Merli, A. Pedretti, F. Adamoli, P. Fornaciari, and G. Gadola. May 1964. 22p.

The site proposed for the PRO organic reactor is located near the Brasimone lake in a valley on the Appennino Tosco-Emiliano, midway between Bologna and Florence. In the course of the reactor design there arose many technical problems, which required original solutions. The problems are related to the: reactor core, with particular reference to fuel element choice and to thermal and nuclear design; core instrumentation, including failed fuel element detection and location system, bearing in mind both the fact that the reactor will be used in the beginning for research purposes, and the possibility of installing a data logger; primary loop, with reference to the choice of the most suitable components and to auxiliary systems; fuel element handling, which takes care of all the problems connected with this operation in an organic reactor; shielding design, with particular reference to the choice of materials and accessibility problems; and control and start-up of the plant, with reference to the particular solutions adopted. (auth)

38525 (A/CONF.28/P/873) HIGH-TEMPERATURE DIRECT CONVERSION REACTOR "ROMASHKA." M. D. Millionshchikov, I. G. Gverdtsiteli, A. S. Abramov, et al. (U.S.S.R.). May 1964. 18p.

A description is given of a high-temperature experimental nuclear power installation consisting of a reactor and a convertor, combined to form a single unit. The main phases of a series of investigations carried out in the course of work on the installation and on individual components are indicated, together with the results obtained. Data are presented on the characteristics of the installation from neutron physics and energy studies and on its basic parameters. (auth)

38526 (A/CONF.28/P/877) NATURAL-URANIUM HEAVY-WATER-MODERATED ORGANIC-COOLED POWER CONVERTER REACTOR. A. I. Alichanov, P. P. Blagovolin, B. I. Ilyiechev, et al. (U.S.S.R.). May 1964. 19p.

Two natural-U heavy-water-moderated organic-cooled reactors are described and compared. The R-1 reactor has greater Pu production efficiency, while the R-2 uses the U more effectively. The coolant, obtained by hydraulic purification of polyalkylbenzol resin fraction, has thermal and physical properties similar to more ordinary organic coolants, but is cheaper. (M.J.T.)

38527 (ANL-6703) EBWR TEST REPORTS (100-Mw(t) OPERATION). (Argonne National Lab., Ill.). Jan. 1964. Contract W-31-109-eng-38. 572p.

Separate abstracts were prepared for each of the five sections and for two of the four appendices; the remaining appendices are on control rod and fuel element location, and test procedures during 1960–62. (R.E.U.)

For abstracts of individual sections see: 37620, 37758, 38528, 38529, 38530, 38531, and 38532.

38528 (ANL-6703(p.39-130)) FUEL. (Argonne National Lab., Ill.).

A summary of fuel loading experiments for 1960–62 is presented. A total of 22 test reports is included. (R.E.U.)

38529 (ANL-6703(p.131-286)) PHYSICS. (Argonne National Lab., Ill.).

A summary of physics experiments on EBWR performed in 1962 and 63 is presented. Included are 14 test reports on startup transients, temperature coefficients, void coefficients, reactivity, poison effects, neutron flux distributions, operational-data analysis, and transfer function measurements. (R.E.U.)

38530 (ANL-6703(p.287-372)) CONTROL AND CONTROL RODS. (Argonne National Lab., Ill.).

A summary of tests on the control system and control

rods of EBWR is presented. A total of 14 reports is included; investigations were made on radiation effects, crud deposition, calibration, and replacement. (R.E.U.)

38531 (ANL-6703(p.373-434)) HYDRAULICS AND HEAT TRANSFER. (Argonne National Lab., Ill.).

A summary of tests performed during 1960, 61, and 62 on the hydraulic and heat transfer systems of EBWR is presented. A total of 9 reports is included on temperature distributions in-core, hydrodynamic tests of instrumented fuel assemblies, and steam qualities. (R.E.U.)

38532 (ANL-6703(p.435-514)) COMPONENTS. (Argonne National Lab., Ill).

A summary of tests performed on components of EBWR is presented. A total of 21 reports for 1960, 61, 62 is included on water volumes, turbine seals, startup instrumentation, EBWR building shell leak rate, shock shield radiochemistry, feedwater filters, subcooler cleaning, purification and decay heat removal systems, boric acid injection, radiation levels, and demister material tests. (R.E.U.)

38533 (APDA-160) DESIGN AND ECONOMIC EVALUATION OF MOBILE BLANKETS FOR FAST REACTORS. A. E. Klickman, A. Amorosi, G. L. Ball, J. J. Edwards, W. H. Jens, B. M. Segal, and R. C. Williams (Atomic Power Development Associates, Inc., Detroit). Mar. 10, 1964. Contract AT(11-1)-865. 52p.

In recent years several new blanket concepts for fast reactors have been advanced and the basic technical feasibility of each has been investigated. Two of these concepts, which have been selected for further study, are discussed. One is a slowly circulating paste concept in which small fuel particles are dispersed in sodium, which serves as the carrier medium but not as a heat-transport medium. The other is a clad-sphere concept, in which small spheres of fuel (about 0.5-inch diameter) are slowly circulated through the reactor with sodium coolant flowing around them to remove heat. In a previous study of fixed-blanket designs, it was found that such a blanket is limited economically by the radial and axial distributions in burnup, heat generation, and plutonium concentration. But no such limitation exists if a mobile form of blanket fuel material is employed. This study, then, is confined to mobile concepts. The study, embodying a fixed set of ground rules, covers the physics, engineering, and economic considerations of the concepts. Relative to the latter consideration, a specific blanket design for each was selected that would effect optimum blanket economics; and a fixed blanket of UO_2 pins was chosen as a standard for comparison of the concepts. To add breadth to the study, each concept was investigated for use with a uranium alloy as well as with a ceramic fuel such as UO_2 or UC. It was concluded from the study that—assuming identical fuel material and economically optimized systems—the paste concept is more economical than the clad-sphere concept. Further, it was found that both mobile blanket concepts are generally more attractive economically when a ceramic fuel material is used than when a uranium alloy fuel material is used. In addition, it was found that systems using the paste concept can be designed that will be economically attractive when compared with a blanket of fixed oxide pins. It would, therefore, appear that this concept should be studied further to allow its early use in a reactor experiment. (auth)

38534 (NAA-SR-Memo-9474) HNPF—MAIN HEAT TRANSFER SYSTEM COMPONENTS PERFORMANCE ANALYSIS. R. R. Stiens (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 18, 1964. Contract [AT(11-1)-Gen-8]. 119p.

A Fortran computer program was developed for the routine performance analysis of the major components of the HNPF main heat transfer system. These components are the six main heat transfer pumps, the three evaporators, three superheaters, and the three intermediate heat exchangers (IHX). Measured or calculated values of performance parameters are compared with values obtained during the rise-to-power testing program, which are considered as the base or reference data. Thus gradual malfunctions of components, or other system anomalies, may be detected as unusual deviations between measured and reference data. A listing of the Fortran source deck, sample data sheets, output from the run, and sample surveillance graphs are presented. (auth)

38535 (TID-20938) BONUS—ELECTRICAL SPECIFICATIONS AND ADDENDA. (Jackson and Moreland, Inc., Boston). [196?]. Contract AT(40-1)-2674. 426p.

Drawings are available as CAPE-1020.

38536 (TID-20939) BONUS—STRUCTURAL SPECIFICATIONS AND ADDENDA. (Jackson and Moreland, Inc., Boston). [196?]. Contract AT(40-1)-2674. 276p.

Drawings are available as CAPE-1020.

38537 (TID-20964) CONSOLIDATED EDISON REACTOR. INTERMEDIATE HAZARDS SUMMARY REPORT. (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). May 1959. Contract AT(30-3)-274. 164p.

Descriptions of the reactor and plant facilities are given. An analysis of potential accidents is presented to demonstrate the ability of the reactor system to limit safely the operation of the plant. The maximum credible accident is postulated and the sequence of events is described. Reactivity accidents such as control rod withdrawal, and mechanical accidents such as loss-of-flow and loss-of-coolant are considered. (R.E.U.)

38538 (TID-21010) HALLAM NUCLEAR POWER FACILITY MONTHLY OPERATING REPORT NO. 23, JUNE 1964. (Consumers Public Power District, Lincoln, Neb.). Contract AT(11-1)-513. 61p.

The HNPF remained shut down for throttle valve top works and plant protective system modifications. Mechanical tests on fuel element orifice drive assembly are discussed. The leakage of a cavity cooling coil is analyzed. The performance of throttle valves is reported. Radiation control and safety reports are given. Maintenance of the steam generator evaporator No. 3, nitrogen system, steam dump system, filters, leak detector, seals, valves, plant control system, radiation detection and monitoring system, and sodium system is reported. Modifications to the primary sodium block valve, sodium secondary flow meter cables, orifice drive mechanism, and maintenance cell are described. (N.W.R.)

38539 (JPRS-26068) PROBLEMS OF BETA-RADIATION AT THE FIRST ATOMIC POWER STATION. I. G. Prostakova and M. S. Yegorov. Translated from Gigiena Truda i Prof. Zabolevaniya, 7: No. 6, 7-9(June 1964). 7p. (TT-64-41338)

Investigations show that, in the work at the Atomic Power Station, there is, besides gamma-irradiation, possible beta-irradiation of service personnel from various sources. During normal operation of the station, beta-irradiation levels for individuals performing basic duties amounted to 0.004 to 0.005 rad per day; beta-irradiation during time of repairs increased to 0.011 to 0.044 rad per day. (auth)

38540 (TID-20953) ARDENNES NUCLEAR POWER PLANT. Quarterly Report No. 7, January 1–March 31, 1964. (Société d'Énergie Nucleaire Franco-Belge des Ardennes, Chooz-lez-Givet, France). Apr. 24, 1964. Work

Performed under United States–Euratom Joint Research and Development Program. 31p. (A translation)

Civil-engineering, nuclear, and design studies on the Ardennes Nuclear Power Plant (SENA Power Reactor) are reviewed. The on-site and off-site construction of components is described. (T.F.H.)

38541 ADVANCES AND TRENDS IN THE DEVELOPMENT OF THE CONSTRUCTION OF GAS-COOLED POWER REACTORS OF THE GRAPHITE-MODERATED NATURAL URANIUM TYPE. P. V. Gilli. Elektrotech. Maschinenbau, 79: 561-6(Nov. 1962). (In German)

A review of the advances and trends in the construction of gas-cooled power reactors is continued and concluded. Improvements in plant lay-out, welding technology, CO_2 compressors, automation, and industrial economy are discussed. (J.S.R.)

38542 CONTROLLING THE REACTORS AT THE HINKLEY POINT POWER STATION. H. Law and R. B. Quarmby (English Electric Co., Whetstone, Leics, Eng.). Ind. At., 8: Nos. 5-6, 71-7(1964). (In French)

The Hinkley Point power station will produce 500 Mwe, using two 980-Mw (thermal) reactors fueled with natural uranium in Magnox alloy containers and cooled with CO_2. The control system for the reactors and its operation are described, including the control rod assemblies and drives. (D.C.W.)

38543 THE USE OF THORIUM IN GAS-COOLED REACTORS. D. L. Booth (English Electric Co. Ltd., Whetstone, Leicester, Eng.). J. Nucl. Energy, Pts. A & B, 18: 361-76(July 1964).

The performance of nuclear power reactors using bars or tubes of thorium metal or of thoria as fuel is discussed. Favorable fueling costs would be obtained if reasonable credits were available for the fissile content of the spent fuel. Operational aspects are briefly discussed. Thorium fuel appears to offer no overriding advantages relative to natural uranium metal fuel for gas-cooled reactors. (auth)

38544 PHYSICS STUDY ON A VARIANT OF THE PRESSURIZED WATER REACTORS. G. Helmis, B. Koehler, K. Meyer, A. Mueller, and A. Rau (VEB Entwicklung und Projektierung Kerntechnischer Anlagen, Berlin). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 457-79 (1961). (In German)

The work of a group of engineers and scientists in increasing the power of the DDR pressurized water reactor from 70 μWe to 100 or 140 μWe is reported. Burnup calculations, control system calculations, unsymmetrical power density in the core region, and reactivity coefficient calculations are discussed. (T.R.H.)

38545 REACTOR SITE AND PLANT LAYOUT. H. F. Peterson, E. J. Barrett, R. F. Jimenez, and B. E. Teeple (General Electric Co., Richland, Wash.). p.439-43 of "Reactor Handbook. Second Edition, Revised and Enlarged. Vol. IV. Engineering." New York, Interscience Publishers, 1964.

Site selection and plant layout considerations for power reactors are discussed. (R.E.U.)

38546 NUCLEAR POWER TECHNOLOGY. F. J. Pearson, ed. New York, Oxford University Press, 1963. 372p. $6.75. (Also available: Oxford University Press, London, 42s).

A brief review of nuclear physics and reactor physics is presented, and heat extraction and temperature, health physics, shielding and containment, types of reactors, reactor control, reactor instrumentation, the production of nuclear materials, the properties of nuclear power materials, irradiation and corrosion properties in reactor technology, nuclear fuel technology, the economics of nuclear power, and possible future reactors are discussed. (C.E.S.)

Process Heat Reactors

38547 (A/CONF.28/P/548) FEASIBILITY OF NUCLEAR REACTORS FOR SEA WATER DISTILLATION IN ISRAEL. F. S. Aschner, S. Yiftah, and P. Glueckstern (Israel Inst. of Tech., Haifa). May 1964. 19p.

Present power capabilities and future requirements in Israel are discussed. The heating requirements, performance ratios, and temperature limitations of flash evaporators for sea water distillation are considered. Dual-purpose nuclear reactors for power and desalination purposes and process heat reactors for low pressure steam generation for desalination are compared technically and economically with conventional steam generation in Israel. Investment costs based on these alternatives and the water prices expected are given. (M.J.T.)

Production Reactors

38548 (A/CONF.28/P/35) OPERATING EXPERIENCE WITH THE G2-G3 REACTORS AT MARCOULE AND STARTING TEST RESULTS FOR THE CHINON EDF I REACTOR. Roger Boussard (France. Commissariat à l' l'Énergie Atomique, Paris), Fernand Conte, and Jean-Michel Stoltz. May 1964. 16p.

The characteristics of the installations G2 and G3 at MARCOULE and EDF 1 at CHINON are summarized, and the main aspects of the testing, startup, and the operation of these reactors are reviewed. Among the various points examined, particular emphasis is given to the devices of original nature, such as tubular fuel elements, flattening of the neutron flux by stuffing, behavior of the reactor tanks and the cooling circuits, the blowers, unloading devices, and data processing. This analysis deals equally with the performances obtained and the difficulties and the various incidents experienced during the initial starting period. Among the more interesting results, the progressive increase in the power of the MARCOULE reactors is mentioned. (auth)

38549 (A/CONF.28/P/674) L'OPTIMALISATION DU COEFFICIENT INITIAL DE RÉGÉNÉRATION D'UN RÉACTEUR NUCLÉAIRE UN PROBLÈME DE LA THÉORIE DES JEUX. (Optimalization of the Initial Conversion Ratio of a Nuclear Reactor Considered as a Games Theory Problem). I. I. Purica (Academia R. P. R. Institutul de Fizică Atomică, Bucharest). May 1964. 4p.

It is shown that the problem of obtaining a maximum initial conversion ratio (by non-homogeneous spatial distribution of the fissile material), together with minimum fuel consumption, has the structure of a two-matrix game with a non-zero sum. The volume of the reactor is regarded as being divided into q separate, indeterminate volumes, each containing $U_i = \mu_i U$ fertile nuclei and $P_i = \xi_i P_c$ fissile nuclei, where U is the total number of fertile nuclei and P_c is the number of fissile nuclei necessary for critical mass. These conditions of maximum density and criticality make it possible to determine the geometrical structure and the value of P_c for a given U and a given distribution (μ_i, ξ_i). (auth)

38550 (A/CONF.28/P/816) ERECTION, TESTING AND OPERATION OF THE RADIOISOTOPE PRODUCTION FACILITY OF THE U.A.R. AEE. M. A. El-Guebeily,

E. Hallaba, M. El Garhy, et al. (United Arab Republic. Atomic Energy Establishment, Inshas, Egypt). May 1964. 12p.

The radioisotope production laboratory includes facilities for the routine production of ^{131}I, ^{198}Au, ^{24}Na, ^{42}K, ^{32}P, ^{35}S, and ^{51}Cr. It also includes other general hot facilities for research and development as well as various facilities for control of production. The main lines of experience gained in erection, testing, and operation of the radioisotope production laboratory, as well as the main lines of development are discussed. (auth)

38551 (ORNL-3572(Vol.II)) THE HIGH FLUX ISOTOPE REACTOR. SELECTED CONSTRUCTION DRAWINGS. VOLUME 2. F. T. Binford and E. N. Cramer, eds. (Oak Ridge National Lab., Tenn.). Aug. 1964. Contract W-7405-eng-26. 184p.

Reproductions of 178 construction drawings, which depict the more important components and systems of HFIR, are presented as a supplement to the descriptive material and schematic drawings contained in Volume I. The drawings for the most part were reduced from the original F and D sizes, and include both Singmaster and Breyer and ORNL materials. (R.E.U.)

Propulsion and Space

38552 (A/CONF.28/P/313) OPERATING EXPERIENCE OF THE ATOMIC POWER PLANT ON THE ICEBREAKER "LENIN." J. J. Aphrikantov, N. M. Mordvinov, P. D. Novikov, B. G. Pologikh, A. K. Sledzjuk, N. S. Khlopkin, and N. M. Tsarev (U.S.S.R.). May 1964. 18p.

A summary is presented of the experience in operating the LENIN atomic plant during 1959 to 1963 in the Arctic region under a variety of conditions. Data are presented on the neutron-physical characteristics of the reactor cores. Maintenance and refuelling are discussed. (D.L.C.)

38553 (A/CONF.28/P/515) THE VULCAIN CORE POWER EXPERIMENT. J. Storrer (Société Belge pour l'Industrie Nucléaire, Brussels) and S. Rigg. May 1964. 15p.

The Vulcain reactor is based on the variable moderation principle, using changing mixtures of light and heavy water, to compensate the decreases in reactivity due to fuel depletion. It permits a longer core life and power operation with all shut-off rods out of the core, leading to an improved neutron economy. After discussing the objectives of the BR-3/Vulcain Power Experiment the paper describes the core and the various modifications to be performed to the BR-3 primary plant, followed by the proposed commissioning and operating programs. The main objectives of the experiment can be summarized as follows: to verify the design parameters of a Vulcain core and its behavior during the whole core life, to experiment the fuel behavior at high burnups, and to test various pieces of equipment. (auth)

38554 (A/CONF.28/P/540) THE REACTOR PLANT OF THE RESEARCH SHIP OF GESELLSCHAFT FUR KERNENERGIEVERWERTUNG IN SCHIFFBAU UND SCHIFFAHRT MBH. HAMBURG–GEESTHACHT. W. Wiebe (Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht, Germany), H. Koenig, and I. Weisbrodt. May 1964. 20p.

The reactor for this ship is an advanced pressurized water reactor. The containment built as a vertical cylindrical vessel is supported from double-bottom and bulkheads in a statically determined way. The reactor compartment is of square section. The secondary shielding is applied on the surrounding bulkheads. Thus it is possible to inspect the whole containment from the outside. A further characteristic of the reactor will permit even inspections on the inside. Forward of the reactor compartment proper lies another compartment for supplementary installations and furthermore a shielded compartment for storage of burnt-up elements. The containment can be entered through an air lock and has several flooding flaps for pressure equalizing in case of sinking. Inside the containment the pressure vessel takes a central position within a shield water tank containing the primary shielding. The pressure vessel encompasses the complete primary cooling system including the heat exchangers. Only the three primary circulating pumps are on the outside being connected to nozzles. All decontamination is performed inside the containment. The primary circuit inside the pressure vessel passes through the core in the lower center position upwards within a chimney toward the surface of the water, and returns through the annulus between chimney and wall of the vessel. The upper part of this annulus contains the tube-bundle system of the heat exchanger. The control rods penetrate the cover of the pressure vessel and are operated from the outside. In addition to the three pump nozzles in the bottom there are three feedwater-inlet and three steam-outlet nozzles in the cylindrical portion of the pressure vessel. The heat exchanger is working in the once-through principle and delivers superheated steam. (auth)

38555 (A/CONF.28/P/565) TECHNICAL OBJECTIVES OF THE VULCAIN REACTOR PROJECT. R. P. Kinsey (United Kingdom Atomic Energy Authority. Reactor Group, Risley, Lancs, England), and P. E. Maldague. May 1964. 13p.

The use of D_2O/H_2O moderators in pressurized water reactors, giving improved neutron economy, and hence lower fuel costs, is being developed for the Vulcain Reactor. A further objective is to attain low capital costs by developing a compact, integral type water reactor with inherent load following characteristics. This type of reactor would also be suitable for small land-based power stations. The program includes engineering research into heat-exchanger design, integral circulating pumps, self pressurization, water treatment, and hydraulic shut-down devices. The optimization of small cores using a mixed D_2O/H_2O moderator leads to a compact highly rated design with low D_2O inventory. This is particularly desirable for a marine system and also minimizes heavy water investment cost. The inherent self regulating characteristics of the Vulcain core are exploited to the extent that it is possible to dispense with conventional control methods for all conditions except xenon poisoning. This is provided for by soluble poison techniques embodied in the primary coolant purification system, thus eliminating mechanical control rods. Positive-acting safety rods are provided which are completely withdrawn from the core during normal operation. (auth)

38556 (A/CONF.28/P/588) THE NERO REACTOR FOR SHIP PROPULSION. M. Bogaardt and M. Muysken (Reactor Centrum Nederland, The Hague). May 1964. 15p.

A description is given of the design of the NERO-reactor for ship propulsion and the experimental work performed to verify the design parameters of the reactor and auxiliary equipment. The design covers a pressurized water reactor installation in which special consideration has been given to obtain a compact installation, a high degree of reliability and safety and a long core life. Novel features of the design are the proposed use of burnable poison incorporated in the uranium–dioxide fuel, an increased water circula-

tion through the core as compared with the circulation through the external circuit obtained by hydraulic ejectors inside the reactor vessel, and a combined unit for heat exchanger, superheater and pump for the external circuit. (auth)

38557 (A/CONF.28/P/748) ON THE DYNAMIC BEHAVIOUR OF BOILING WATER SHIP REACTORS. H. Christensen, K. O. Solberg, and A. O. Waagboe (Norway. Institutt for Atomenergi, Kjeller). May 1964. 15p.

Boiling water reactors with natural circulation are inherently simple, and this type is economically attractive for small size, nuclear power plants. Such reactors are, however, particularly sensitive to accelerational disturbances, and, in the past, have been discarded for ship propulsion use. Results from a comprehensive study of the dynamic characteristics of boiling water reactors for marine use, with special attention to the applicability of natural circulation, are given. It is shown that large nuclear power transients can certainly be expected, but the resulting variations in fuel temperature, heat flow to coolant, reactor pressure, and steam flow to turbine are all within tolerable limits. It is concluded that although the nuclear power transients will inconvenience the designers of control systems, a natural circulation system can be operated reliably and safely at full power even under adverse sea conditions. Further, relatively simple means exist for improving the dynamic performance. (auth)

38558 (A/CONF.28/P/801) TWO-PHASE FLOW INVESTIGATIONS FOR A MARINE BOILING WATER REACTOR. E. Kjelland-Fosterud, I. Bencze, B. Kierulf, and O. R. Kolberg (Norway. Institutt for Atomenergi, Kjeller). May 1964. 15p.

Research done to predict the dynamic behavior of a boiling reactor in a seaway is described. The hydraulic circuit was investigated experimentally, and results were used as a partial check on the validity of a mathematical dynamics model for the reactor. Tests were done in a 30 kw, 50 atm natural circulation loop which can be oscillated vertically. A design giving freedom to vary the inertia of the circulating water in the downcomer within wide limits is described. It is proposed to use a combined steam injector-jet pump for forced circulation to improve reactor stability. The injector theory is explained, and data from a loop with maximum pressure 100 atm and maximum power 300 kw is reviewed. The effect of the injector on reactor design and behavior is discussed. Carry-under of steam into the downcomer, which greatly affects circulation, was studied in the mobile loop and in large-scale air–water loops; geometrical effects were found important, and experimental results from their investigation are given. (M.J.T.)

38559 (AED-C-22-02) NUCLEAR SHIP PROPULSION. Series C: Bibliographies. J. N. Paro, comp. (Reactor Centrum Nederland, The Hague). Apr. 1964. 41p.

Information on nuclear ship propulsion taken from Dutch, English, and German literature is given in the 114 references cited. The majority of the titles are from English papers and possess Nuclear Science Abstracts numbers. Indexes are based on report numbers, authors, and subjects. (R.E.U.)

38560 (NAA-SR-Memo-9361) RELIABILITY ESTIMATES FOR MULTIPLE CRU RANKINE CYCLE SYSTEMS. D. S. Burgess (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 4, 1964. Contract [AT(11-1)-Gen-8]. 35p.

For multiple CRU systems of larger numbers such as 5 or more the total system reliability is significantly reduced by the complexity of the power conversion system interfaces, i.e., the boilers and the electrical power distribution equipment. The total system reliability is limited by the reliability of the primary system, which includes the reactor and NaK components. Objectives necessary for a 20-Kw system using at least 4 out of 5 CRU's for reliability of 0.99 are given. The objectives are extremely stringent; the feasibility of meeting them remains to be estimated. Application of multiple CRU systems for manned space stations might eliminate the critical reliability effect of the electrical load distribution and switching equipment. Such equipment could be considered maintainable with replacement and alternate modes of operation available. Based on meeting a reliability objective of 0.95 for up to 20-Kw power, the objectives recommended for manned system application are given. (auth)

38561 (NAA-SR-Memo-9375) R-C 14 STRUCTURAL ANALYSIS. J. G. Fish (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 5, 1964. Contract [AT(11-1)-Gen-8]. 139p.

The radiator-condenser (R-C 14) design is basically a cone of semimoncoque construction. It is comprised of 1100-0 aluminum skin backed with 6Al-4V titanium hat sections, Haynes 25 longitudinal tubes and 6Al-4V titanium circular frames. Materials were selected for their heat transfer and strength characteristics so that the resulting structure was light weight and capable of meeting the performance and structural requirements. Other considerations in the design besides performance and weight were: ease of fabrication, costs, time associated with the fabrication process, and reliability. The results of the analysis established that the R-C 14 design is capable of successfully meeting all of the established structural criteria associated with all known ground, flight, and orbital environments. (auth)

38562 (NAA-SR-Memo-9399) TORQUE REACTIONS ON THE SNAP-2 REACTOR-REFLECTOR. PART II. D. Chin (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 3, 1964. Contract [AT(11-1)-Gen-8]. 26p.

The torques being transmitted to the reactor-reflector assembly were computed for stepping in of the fine control drum in $\frac{1}{8}$° intervals. Although the net torque impulse is zero for any system where there are no external torques acting, the instantaneous torques at any given time may affect the orientation and stability of the vehicle in free space. It is the primary objective of the report to determine these periodic torques. A harmonic analysis was made to determine the periodic torques for various actuation times. A computer program was written to evaluate these periodic torques. (auth)

38563 (NAA-SR-Memo-9440) FSM-I — A DATA REDUCTION PROGRAM. R. J. Mikell and G. T. Chang (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 1964. Contract [AT(11-1)-Gen-8]. 101p.

The FSM-I data reduction program consists of three parts. Part I is a data reduction and analysis program, which performs statistical calculations and numerical analyses of data gathered on punched paper tape. The signals to the paper tape punch are obtained from reactor instrumentation. One of the output media from Part I is a magnetic tape. This tape is used as the input to Part II. Part II is the IBSYS sort program. This program takes the output magnetic tapes generated by Part I, sorts and merges the data, and, if desired, deletes records from the sorted and merged tapes. This is done in order to update a history tape of accumulated test runs processed by Part I. This

accumulated history tape then becomes the input to Part III. Part III is a normalizing and graphical display program. In this portion of the FSM-I package, plots of the various parameters which describe the system's performance are obtained. The programs were written for IBM 7090 or 7094 in FORTRAN II for flight systems tests of SNAP 10A. (auth)

38564 (SC-DC-3409) ENVIRONMENTAL TESTING OF THE SNAP-10A SAFETY FLIGHT VEHICLE. D. L. Krenz (Sandia Corp., Albuquerque, N. Mex.). Aug. 1963. Contract AT(29-1)-789. 39p. (CONF-282-1)

From Aerospace Reliability and Maintainability Conference, Washington, D. C., June-July 1964.

The environmental testing of the flight vehicle for the SNAP 10A reactor is discussed; the environments, test parameters, and testing techniques are described. The test took place from Wallops Island on May 22, 1963. (R.E.U.)

38565 NUCLEAR PROPULSION BY MITCHELL-FAIRFIELD. NEW MARINE SYSTEM OF LONG LIFE AND LOW WEIGHT. Gordon Jackson. Impulse, No. 24, 6-11(1964).

The design of a water-moderated, steam-cooled marine reactor is presented. The core coolant flow, moderator flow, heat exchangers, turbo circulators, core design, and containment are discussed. The reactor uses hollow fuel pellets of UO_2. (C.E.S.)

38566 ÜBER DEN EINFLUSS DES KERNENERGIEANTRIEBES AUF DEN ENTWURF GROSSEN UND SCHNELLEN FAHRGASTSCHIFFEN. (Effects of Nuclear Energy Propulsion on the Design of Passenger Ships). Karl-Rainer Repetzki. Thesis, Berlin, Technische Universität, 1961. 56p.

The effects of nuclear propulsion on the design of passenger ships were investigated using two ship models—passenger ships for transatlantic trade with a capacity of 6000 passengers and operating speeds of 31 and 34 knots. The reactors suitable for ship propulsion were analyzed, and the effect of reactor weight and dimensions on the output was studied. The ship design for each model was given for four reactor drives. (J.S.R.)

Research and Test Reactors

Refer also to abstract 38384.

38567 (A/CONF.28/P/2) UTILIZATION OF CANADIAN RESEARCH REACTORS. D. G. Hurst (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.), R. E. Manson, E. Critoph, and H. E. Petch. May 1964. 13p.

The uses of the high-flux Chalk River research reactors NRX and NRU, and of the pool-type reactor at McMaster University (MNR) are described. Experimental facilities for the reactors are discussed. (R.E.U.)

38568 (A/CONF.28/P/8) PERFORMANCE AND PROBLEMS OF NPD. L. W. Woodhead (Ontario. Hydro-electric Power Commission, Toronto), and W. M. Brown. May 1964. 15p.

The performance and major difficulties of the NPD reactor are summarized. Operating and maintenance costs have been as expected, and fuel costs appear equally satisfactory. The capacity factors also compare favorably with design values. A reduction of D_2O loss costs was achieved by a closed dry-cycle principle, and no fuel failures were encountered. (D.C.W.)

38569 (A/CONF.28/P/9) NPD START-UP, REACTIVITY BALANCE AND FUEL MANAGEMENT. J. W. Hilborn (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.), W. M. Barss, M. F. Duret, J. R. Dickinson, A. C. Whittier, and E. Horton. May 1964. 13p.

The NPD reactor, a 20-Mwe model of the CANDU reactor, first went critical in April 1962. The initial approach to criticality is briefly described, and the results of measurements of flux and power distributions and of reactivity coefficients, balance, and worths are presented and compared with appropriate calculations. Fuel schedule calculations are also outlined. (D.C.W.)

38570 (A/CONF.28/P/12) RESEARCH WITH INELASTIC NEUTRON SCATTERING AT THE NRU REACTOR. B. N. Brockhouse (McMaster Univ., Hamilton, Ont.), A. D. B. Woods, G. Dolling, and I. M. Thorson. May 1964. 13p.

The neutron inelastic scattering measurements performed at the NRU reactor are outlined, including measurements of the scattering cross sections of thermal reactor materials and observations on the dynamics of crystals, liquids, and systems of coupled magnetic moments. The spectrometers are also briefly described. (D.C.W.)

38571 (A/CONF.28/P/14) THE INSTALLATION, OPERATION AND MAINTENANCE OF EXPERIMENTAL LOOPS IN REACTORS. J. C. Horsman, L. R. Fleming, and J. N. Robertson (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.). May 1964. 12p.

The characteristics and uses of the loops in NRU and NRX are indicated. The loops in NRU are described, together with some problems encountered in their design and operation. Included are loops cooled with water, steam, steam-water mixtures and organic liquids. The data processing system developed for loop experiments is also discussed. (D.C.W.)

38572 (A/CONF.28/P/33) USE AND EVOLUTION OF THE RESEARCH REACTORS OF THE C.E.A. Claude Chauvez and Francois Rossillon (France. Commissariat à l'Energie Atomique, Paris). May 1964. 14p.

The different research reactors in use in the French C.E.A. Nuclear Centers are examined. The histories of these reactors are traced, describing how they have been used up to the present, and how they have been adapted to changes in program by means of certain modifications. The reasons leading to the elaboration of the project for the reactor Osiris are described. Zoe, EL 2, EL 3, Triton I and II, Melusine, Siloe, and Pegase are also described. (T.F.H.)

38573 (A/CONF.28/P/34) A SURVEY OF EXPERIMENTAL FACILITIES AND FLUX MEASUREMENT USED IN C.E.A. RESEARCH REACTORS. François Rossillon and Claude de Chauvez (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 19p.

The uses of irradiation facilities associated with C.E.A. research reactors are reviewed. Technological considerations in the design and construction of research facilities are discussed. (R.E.U.)

38574 (A/CONF.28/P/42) RAPSODIE. G. Vendryes (France. Commissariat à l'Energie Atomique, Paris). May 1964. 18p.

The principal neutron and thermal characteristics, the fuel and breeding assemblies, the reactor block and cooling circuits, and the principles and modes of operating on the control and safety of the reactor are discussed. (auth)

38575 (A/CONF.28/P/47) SILOE AND OSIRIS. Jean Chatoux (France. Commissariat à l'Énergie Atomique,

Paris); Guy Denielou, Bernard Lerouge, and Olivier de Kervanoael. May 1964. 19p.

SILOE and OSIRIS are two new general purpose research reactors of the "Commissariat à l'Energie Atomique." SILOE, located within the "Centre d'Etudes Nucléaires" of GRENOBLE is a swimming pool reactor of the same type as MELUSINE and TRITON. It operates at a nominal power of 15 Mw thermal and has reached the peak power of 20 Mw thermal with two thirds of its cooling system working. The fast flux above 1 Mev, which is maximum at the center of the core at 15 Mw thermal is 1.2×10^{14}. The core, quite open, is downward cooled. Average specific power is 159 kw/l. OSIRIS is under construction at SACLAY. Designed for 50 Mw thermal, this reactor is upward cooled. The fast flux at the center of the core above 1 Mev is calculated to be 2.5×10^{14}. The average designed specific power is 280 kw/l. A fixed zircalloy gamma shield makes a box round the core. Future perspectives open to non-pressurized swimming-pool reactors are examined. Ways are suggested for neutronic; thermal and shielding modifications which make possible further improvements in the performances and economy of these devices. (auth)

38576 (A/CONF.28/P/48) PEGASE, FUEL TESTING REACTOR. Robert Dautray (France. Commissariat à l'Énergie Atomique, Paris); Victor Raievski, and Roger Arditti. May 1964. 8p.

The reactor Pégase is designed for testing fuel elements for gas-cooled power reactors. Pégase is composed of a parallelepipediccore of enriched uranium, moderated and cooled by pressurized water. This core is used as a neutron source for eight autonomous loops, containing the elements to be tested, and situated around the core. The core and the eight loops are immersed in a irradiation pool. The loops are placed on the bottom of the pool so that it is possible to move a loop away from the core, or to remove it from the pool without interfering with the operation of the other loops. The studies on Peggy (zero-power model of Pégase) and loop prototype are described. Pégase reached its 30-Mw power level on May 28, 1963. (D.L.C.)

38577 (A/CONF.28/P/49) HIGH-FLUX-BEAM RESEARCH REACTOR. P. Ageron (France. Commissariat à l'Énergie Atomique, Paris); G. Denielou, R. Dautray, J. Fournier, B. Jacrot, P. Perroud, J. Lacaze, and L. Weil. May 1964. 19p.

A closed-core, nonpressurized, swimming-pool reactor, highly under-moderated by the light-water coolant and heavy-water reflector, was proposed for provision of high-flux neutron beams. A cold neutron source was particularly considered. (D.C.W.)

38578 (A/CONF.28/P/78) ESSOR—SPECIFIC TEST REACTOR FOR HEAVY WATER REACTOR CONCEPTS DEVELOPED BY EURATOM. J. C. Leny (European Atomic Energy Community); A. Ertaud, C. D'Ayguesvives, J. P. Crette, and J. Panossian. May 1964. 17p.

Essor is a heavy water-moderated reactor intended for tests of channels and organic coolants in the development of the Orgel reactor. The core comprises 12 Orgel fuel elements surrounded by a ring of 16 booster fuel elements, and the thermal neutron flux in the central zone can reach 2×10^{14} n/cm^2/sec. The components of the reactor and some of the design work are described. Construction was begun in 1963 and should be completed by 1967. (D.L.C.)

38579 (A/CONF.28/P/103) THE CABRI REACTOR. Jean Ailloud and Jean-Paul Millot (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 12p.

CABRI is a swimming pool reactor intended for safety studies of water reactors. These studies and other aims of the reactor are considered in detail. The instrumentation for the nuclear and non-nuclear measurements is discussed. Finally, descriptions are given of the reactor and its installations. (D.L.C.)

38580 (A/CONF.28/P/116) OPERATION AND EXPERIMENTAL UTILIZATION OF THE HIGH-FLUX RESEARCH REACTOR DR 3. S. Mehlsen, I. Rasmussen, and Th. Friis Soerensen (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). May 1964. 12p.

The performance of the Dido-type Danish Reactor (DR 3) is reported. Some experiments are reviewed. (R.E.U.)

38581 (A/CONF.28/P/118) OBJECTIVES, ORGANIZATIONAL ASPECTS AND UTILIZATION OF THE IEA-R1 RESEARCH REACTOR. Azor C. Penteado Filho, Silvio B. Herdade, and Dirceu M. Vizeu (Brazil. Instituto de Energia Atômica, São Paulo). May 1964. 14p.

Reactor operating experiences are reported for the Brazilian research reactor IEA-R1. The reactor is of the swimming pool type with 20% enrichment. (R.E.U.)

38582 (A/CONF.28/P/119) SIX YEARS OF UTILIZATION OF THE POLISH RESEARCH REACTOR "EWA". J. Aleksandrowicz, B. Buras, R. Plejewski, and S. Siekierski (Polish Academy of Sciences. Inst. of Nuclear Research, Swierk). May 1964. 12p.

The uses of the Polish research reactor EWA at Świerk are reviewed for 6 years of operation. The reactor is water-moderated and -cooled, uses enriched (10%) uranium, and is a 2-Mw tank-type facility with an average thermal flux of 10^{13} neutrons/cm^2 · sec. Research in solid-state, nuclear, and reactor physics, chemical research, and isotope production is reviewed. (R.E.U.)

38583 (A/CONF.28/P/120) RESEARCH REACTORS IN JAPAN. [Japan Atomic Energy Research Inst., Tokyo]. May 1964. 12p.

The roles played by research reactors in Japan are discussed. (R.E.U.)

38584 (A/CONF.28/P/123) EXPERIENCE OF OPERATION AND USE OF THE U. K. HIGH-FLUX RESEARCH REACTORS. R. J. Jackson, ed. (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). May 1964. 15p.

The principal features of the three similar U. K. heavy water high flux research reactors, DIDO and PLUTO at Harwell and the Dounreay Materials Testing Reactor are briefly recalled. The breakdown of effort in aid of specific power projects, general reactor technology, basic research, and isotope production is given. Brief reference is made to the 5 Mw light water pool reactor HERALD at Aldermaston and its merits for certain kinds of experiment are noted. Physics measurements of flux and reactivity are made in a zero energy reactor DAPHNE, at Harwell. Brief mention is made of the health physics arrangement to detect and control leakage of radioactive species from either the reactor or experiments into the environment. Experience of tritium is particularly discussed. The requirements for even higher flux thermal neutron beams have given rise to discussions about new systems devoted explicitly to neutron beam work. A brief review is made of the potential for further development of general purpose reactors of this class. (auth)

38585 (A/CONF.28/P/134) EXPERIMENTAL EQUIPMENT ASSOCIATED WITH THE UNITED KINGDOM HIGH-FLUX RESEARCH REACTORS. V. S. Crocker (United Kingdom Atomic Energy Authority. Research Group.

Atomic Energy Research Establishment, Harwell, Berks, England). May 1964. 15p.

The diversified use of DIDO, PLUTO, and DMTR reactors has led to a wide variety of designs of experimental equipment and the most interesting and important of these are discussed. A substantial part of the irradiation program has been concerned with the behavior of non-fissile specimens in high fast neutron fluxes. The evolution of rigs for this type of experiment is described. The original design was for irradiating graphite samples at a few hundred degrees centigrade, while later rigs now accommodate a wide variety of materials at temperatures up to 1500°C. A rig for fissile specimens which has similarly undergone several stages of development is also described. The high-pressure water loop in DIDO has been working satisfactorily for several years. The principal features of the loop are outlined and modifications to allow up to four individual experimental holes to be cooled by parallel water currents from the one high-pressure water system are discussed. The High-Temperature Gas-Cooled Loop, which is installed in PLUTO has been used exclusively by the O.E.C.D. DRAGON Project. The design concept of this loop, together with some commissioning problems and operational experience using possible DRAGON Reactor fuel elements, is recounted. Quite different problems have arisen in the provision of rigs for producing 'cold' (15–45°K) and 'hot' (~ 1100°K) neutron beams. These are discussed together with the operation of the liquid-hydrogen moderator chamber in DIDO. Finally, the future requirements for rigs, especially with regard to temperature, are discussed and some of the proposals for meeting them described. (auth)

38586 (A/CONF.28/P/189) RESEARCH WORK DONE WITH THE VVR-S, EXPERIMENTAL REACTOR OF THE ATOMIC PHYSICS INSTITUTE IN BUCHAREST (RUMANIA). Horia Hulubei (Academia R. P. R. Institutul de Fizică Atomică, Bucharest). May 1964. 16p.

Experiments in nuclear physics, neutron physics and optics, nuclear chemistry, and radioisotope production performed in the VVR-S reactor in Bucharest are briefly outlined. (C.E.S.)

38587 (A/CONF.28/P/296) REVIEW OF RESEARCH REACTOR ACTIVITIES IN THE SOVIET UNION. V. V. Goncharov (U.S.S.R.). May 1964. 13p.

Research reactors of various types and for various applications were developed in the USSR. The main lines of the development on research reactors are described. Development of a unique research reactor with a super-high neutron flux and the lines of the future development is discussed. Reactor SM-2 operates at the design power of 50 megawatts. A thermal neutron flux of 3×10^{15} n/cm^2/sec was obtained in the neutron trap. The reactor is designed for production of transuranium elements and for carrying out physical and engineering research. Physical and operational characteristics of reactor SM-2 are presented. Development of research reactors of new construction for testing fuel elements and materials (pressurized reactors, swimming-pool reactors) is discussed. A comparative analysis is made of modern loop reactors, the main engineering and physical problems involved in development and operation of such reactors are discussed and the essential features of new reactors which provide much better conditions for testing fuel elements and materials are noted. Increase of the neutron flux in the operating reactors and expansion of their experimental possibilities are considered. The most important improvements made in the operating reactors with neutron fluxes of 10^{13} and 10^{14} n/cm^2/sec are described. (auth)

38588 (A/CONF.28/P/312) 5-YEAR OPERATION EXPERIENCE ON REACTOR BR-5. A. I. Leipunskii, O. D. Kazachkovskii, M. S. Pinkhasik, et al. (U.S.S.R.). May 1964. 15p.

Principal results of the operation of the sodium-cooled fast reactor BR-5 of nominal power 5000 kw are presented. Reactor operation after the design burnup of 2% with some loose fuel elements is described. Fission-product contamination of the coolant, technical equipment, pinning surfaces, and gas blanket was analyzed. The primary-coolant residual activity was caused by ^{137}Cs. Only Xe and Kr isotopes were released into the gas blanket during reactor operation. Radiochemical studies were made of samples of the coolant and deposits on pipe inner surfaces. Results of investigation of plutonium oxide fuel elements with more than 5.5% burnup are described, and the causes of fuel-element canning rupture are analyzed. Results of a kinetic study using a step-function method are described and compared with oscillation-method data. Transient response of power to reactivity for different coolant flow rates was obtained. Some UC fuel elements are being irradiated in the core. (auth)

38589 (A/CONF.28/P/320) PHYSICAL AND OPERATIONAL CHARACTERISTICS OF REACTOR SM-2. S. M. Feinberg, N. A. Dollezhal, E. D. Vorobjov, et al. (U.S.S.R.). May 1964. 20p.

The main experiments conducted to ascertain separate parameters of the SM-2 reactor and problems of its operation are described. The experimental results obtain are compared with the theoretical calculations. Some design changes made in the period of adjustment and operation of the reactor are also described. Dependence between the critical charge of the reactor and the configuration of the core, change in reactivity as the uranium-235 burns out, change in reactivity after the replacement of burnt-up fuel units by fresh ones, control rod effectiveness, neutron spectrum, slow-neutron distribution throughout the reactor volume, effects of various materials placed in the central cavity and other vertical channels on reactivity and slow-neutron distribution, and poisoning, are discussed. (auth)

38590 (A/CONF.28/P/321) SPECIFIC PROBLEMS OF DESIGNING RESEARCH REACTORS DESIGN WITH TEST LOOPS. (LOOP-TYPE REACTOR). THE MIR LOOP-TYPE REACTOR. A. P. Bovin, Y. M. Bulkin, G. V. Vasenkova, et al. (U.S.S.R.). May 1964. 15p.

Modern loop-type reactors are compared, and the main engineering and physical problems of their construction and operation are discussed. Four types of powerful loop-type reactors are compared: vessel-type reactors, vessel-type swimming-pool reactors, channel-type reactors, and channel-type swimming-pool reactors. The MIR research loop-type reactor is described. The MIR is a channel-type swimming-pool reactor. Problems characteristic of loop-type reactors are considered. (auth)

38591 (A/CONF.28/P/322) THE PULSE REACTOR POTENTIALITIES. I. FOR NEUTRINO INVESTIGATIONS. S. M. Feinberg and Ya. V. Shevelev (U.S.S.R.). May 1964. 8p.

A pulsed reactor differs from the common type in that it operates in cycles, the cycle including the operation and cooling stages. Within certain limits, the higher the cooling time to operation time ratio (duty ratio) the cheaper is the realization of the desired neutrons flux. There are the following types of pulsed reactors: the pulsed type proper, the cycle pile, and the homogeneous reactor. The difference between the two latter types is to a certain degree a conditional one—in the cycle pile the core moves

along the reactor body, while in the homogeneous type the situation is reversed. Several possible versions of such reactors are discussed and compared, and neutron physics and engineering aspects of the problem are studied. (auth)

38592 (A/CONF.28/P/322a) PULSE REACTOR POTENTIALITIES. II. IGR PULSE GRAPHITE REACTOR. I. V. Kurchatov, S. M. Feinberg, N. A. Dollezhal, et al. (U.S.S.R.). May 1964. 15p.

The design, operation behavior, peculiarities of reactor pile mounting, physical characteristics, and control of the IGR Reactor are discussed. (C.E.S.)

38593 (A/CONF.28/P/323) THE MP RESEARCH REACTOR FOR TESTING FUEL ELEMENTS AND MATERIALS. V. V. Goncharov, Y. G. Nikolaev, E. N. Babulevich, et al. (U.S.S.R.). May 1964. 16p.

A new research reactor MP of an original design is described. This reactor was built for testing fuel elements and materials. It combines the advantages of a pool-type reactor and those of a channel-type reactor. The reactor power is equal to 20 MW. The maximum thermal neutron fluxes on uranium and in the neutron trap equal $2 \cdot 10^{14}$ and $6 \cdot 10^{14}$ n/cm^2 sec respectively. Highly enriched uranium is used as a fuel. The reactor fuel assemblies consist of several thin-walled, three-layer, tubular fuel elements each provided with three longitudinal spacing ribs; the central or fuel layer of a fuel element has a uniform thickness. The fuel assemblies are loaded into the channels and are water-cooled under pressure. The channels form a square lattice of a spacing widening in the bottom-to-top direction, i.e., all the reactor channels, except the central one, are inclined. Within the reactor core, of 1 m high, blocks made of metallic beryllium are installed between the channels; the side reflector is assembled of graphite blocks enclosed in an aluminum can. The heat-transfer agent (ordinary water) is conveyed to and drained from each channel from the top. The core, channels, water coolant tubes, and their collectors are submerged in the water pool. Besides the first circuit with water under pressure for cooling fuel elements, there is another circuit in which the pool water circulates to cool the beryllium and graphite blocks of the core and reflector stacking. Uniflow U-shaped loop channels are installed in nine points of the core and in four points of the reflector. The maximum diameter of the loop channel equals 150 mm in the core, and 220 mm in the reflector. The reactor is also furnished with a number of experimental channels for irradiation of materials. Besides that, the material samples can be irradiated in the central part of the fuel assembly of any channel of the reactor. All main design units and technological systems of the reactor and its loop units are described. The principal characteristics of the experimental loops of the MP reactor are described: water loop with a volumetric water boiling in the core; non-boiling water loop; water loop with volumetric water boiling in the core and with the equipment made of carbon steel; loop with organic coolants, gas loop with carbon dioxide coolant, gas loop with helium coolant. The reactor physical and technical characteristics obtained during its physical startup and in the course of reaching its rated capacity are given. (auth)

38594 (A/CONF.28/P/324) OPERATING EXPERIENCE WITH PFR REACTOR, ITS USE FOR NEUTRON INVESTIGATIONS AND ITS CHARACTERISTICS ON NEUTRON INJECTION FROM A MICROTRON. B. N. Bunin, I. M. Matora, S. K. Nikolaev, L. B. Pikelner, I. M. Frank, E. P. Shabalin, F. L. Shapiro, and Yu. S. Yazvitskii (U.S.S.R.). May 1964. 20p.

The experience of the three-year operation of the pulsed fast reactor is described. The main disadvantage of the PFR, as a pulsed source for neutron spectrometry, is a long duration of a burst. In this connection work was performed on the construction of the injector of fast neutrons multiplying the PFR operating in subcritical mode. The use of the subcritical system for multiplying neutrons from a pulsed accelerator comes across some difficulties connected with delayed neutrons multiplication. In the pulsed reactor the multiplication coefficient reaches some large magnitude only for a very short period of time. As a result, multiplication takes place only for prompt neutrons, while the average magnitude of the multiplication coefficient for delayed ones is small. This permits the use of PFR for the neutron multiplication. A burst is initiated by photoneutrons from bremsstrahlung of fast electrons generated by a microtron. Peculiarities of such a system in different conditions of operation are considered. (auth)

38595 (A/CONF.28/P/325) THE EXPERIENCE OF OPERATION AND USE OF THE RESEARCH WWR-M REACTOR WITH MAXIMUM NEUTRON FLUX 3.10^{14} n/cm^2 · sec. D. M. Kaminker and K. A. Konoplev (U.S.S.R.) May 1964. 15p.

The 10-Mw, light-water-moderated, beryllium-reflected reactor is briefly described, together with its operation, irradiation facilities, and associated experimental program. (D.C.W.)

38596 (A/CONF.28/P/441) IN-PILE EXPERIMENTAL EQUIPMENT FOR BR2. J. Planquart (Centre d'Étude l'Énergie Nucléaire, Brussels). May 1964. 19p.

A description is given of some of the principal in-pile irradiation devices for use in the high flux research reactor BR2. Points of discussion deal mainly with the application of engineering principles to the problems encountered in submitting both fissile and non-fissile materials to a neutron flux. (auth)

38597 (A/CONF.28/P/446) STUDY OF THE BR2 NUCLEAR CHARACTERISTICS BY MEANS OF ITS MOCK-UP BRO2. F. Motte, J. Debrue, H. Lenders, and A. Fabry (Centre d'Etude l'Energie Nucleaire, Brussels). May 1964. 20p.

The determination of the nuclear characteristics of the materials testing reactor BR2 is founded essentially on the measurements made in the reactor BRO2, the nuclear mock-up of BR2. The correlation between the two systems, as is described, is based upon a correct forecast of the BR2 behavior from the tests conducted in BRO2. The increase to full power operation of BR2 was executed in two stages, one in 1962 and the other in 1963; prior to this, an experimental study was made in BRO2 on the selected core configuration of fourteen fuel elements. This study is presented briefly; it deals with the following items: macroscopic flux distributions, fine flux structure, neutron spectra, reactivity value of fuel and poison, and reactivity worth of control rods. This information establishes the reactivity balance and the associated control rods shift at any time during the BR2 high flux operation and also contributes to the knowledge of the hot spot factors. The observations and measurements done in BR2 allow one to verify the established forecasts, and more particularly to evaluate the validity of some simulation models adopted in BRO2. The measurements carried out in BR2 during the high-power operation periods and at low-power level, during the reactor shut-downs, are described; they lead to the determination of the reactor characteristics evaluation during fuel burnup: excess of reactivity, flux levels, neutron and gamma heating distributions, neutron spectra and

fine flux structure; more particularly and in accordance with one of the more important objectives of the tests, the highest operation level, expressed in terms of maximum heat flux, can be deduced. (auth)

38598 (A/CONF.28/P/451) FIVE YEARS' EXPERIENCE WITH THE HUNGARIAN WWRS-TYPE REACTOR. F. Szabó and L. Várkonyi (Magyar Tudományos Akademia Központi Fizikai Kutató Intézete, Budapest). May 1964. 13p.

Operation of the 2 Mw thermal water-cooled and -moderated research reactor at Budapest since 1959 is reviewed. Its use for the study of problems in reactor and nuclear physics, solid state physics, and nuclear chemistry is surveyed. The routine production of radioisotopes and an investigation of the radiolytic behavior of organics for reactor coolant-moderators are described. (M.J.T.)

38599 (A/CONF.28/P/453) THE UTILIZATION OF THE 2 MW RESEARCH REACTOR OF THE UARAEE (UA-RR-1) FOR PHYSICS RESEARCH AND ISOTOPE IRRADIATION. I. Hamouda, O. El Mofty, Y. El Meshad, and M. El Nagdy (United Arab Republic. Atomic Energy Establishment, Inshas, Egypt). May 1964. 12p.

The UA-RR-1 is a pool type reactor which was purchased in the USSR on a bilateral agreement. The purpose of the reactor is to conduct research in the fields of physics, chemistry and biology, to produce radioisotopes and to provide training in reactor engineering. The operating conditions and co-ordination of the different uses of the reactor as well as the development of the physics research program utilizing this reactor are described. (T.R.H.)

38600 (A/CONF.28/P/480) SEPARATION OF THE COLD NEUTRONS FROM THE SPECTRUM OF HORIZONTAL BEAMS OF A V.V.R.-S REACTOR. D. Bally, M. Popovici, B. Grabcev, and M. Popescu (Academia R. P. R. Institutul de Fizică Atomică, Bucharest). May 1964. 17p.

The introduction in a reactor neutron beam of a system of surfaces allowing total multiple neutron reflection may provide an efficient means for obtaining relatively intensive neutron beams, whose spectrum is shifted to the low energy domain relative to the neutron spectrum incident on the system. The purpose of the present paper was to establish the efficiency of this method as a function of quality of the reflective surface, the angular horizontal divergence defined by the reflectant surfaces, and the axis angle of the two elements defining the thermal neutron path. The measurements have been performed at the VVRS reactor horizontal neutron beam placing in the neutron beam a system containing two collimators with variable aperture, with axes at a variable angle. The experimental data showed that the building of a reflectant collimator system of "Soller type" is possible; such a system is in course of assembling to the VVRS reactor beam. (T.R.H.)

38601 (A/CONF.28/P/481) RESEARCH REACTOR AND ITS UTILIZATION IN THE REPUBLIC OF CHINA. Chen-hwa Cheng (National Tsing Hua Univ., Hsinchu, Taiwan, China). May 1964. 19p.

The THOR (Tsing Hua Open-pool Reactor) at the National Tsing Hua University is described, and research activities are reviewed. THOR, the first in the Republic of China, is a 1-Mw light water-moderated and -cooled, graphite reflected heterogeneous reactor. (R.E.U.)

38602 (A/CONF.28/P/485) DEVELOPMENTS IN FUEL FABRICATION FOR RESEARCH REACTORS IN BRAZIL. T. D. de Souza Santos, H. M. Haydt, and C. T. Freitas (São Paulo, Brazil. Universidade. Instituto de Energia Atômica). May 1964. 15p.

The experimental studies carried out on the fabrication of fuel elements for the Argonaut reactor and for the Re-Suco subcritical assembly loaded with 40.1-mm UO_2 pellets are described. Before the actual fabrication of the fuel plates for the Argonaut reactor was started, extensive experimental studies with cermets of 50% natural U_3O_8 and 50% Al powder were conducted. Utilizing U_3O_8 powder of the same grain size of that of the 20% enriched oxide, the essential variables of the fabrication process were determined. After study of the cast cladding process, the procedure was evolved to roll bonding of picture frame sets comprising the cermet, which was previously sintered under argon. Two complete mock-up fuel elements with natural U were built to check the reproducibility of the results before the production of the actual fuel plates was started. The picture frame sets were designed to provide complete cladding, including the ends of the plates, to the finally deformed thin core. Each fuel element comprises 17 plates, 2.5 mm thick, 72.5 mm wide and 610 mm long, with face cladding of 0.35 mm thick. Each plate contains 19.3 g of U-235. Experimental work consisted mainly of: charge preparation; compacting under variable pressures in dies of different geometries; presintering of the compacts under argon; assembly of the picture frame components; hot-rolling of the assembled welded sets, and the final cold rolling operations to meet the dimensional and physical specifications of the fuel plates. The Re-suco sub-critical assembly contains 313 fuel elements, 1100 aluminum alloy tubes of 44 mm outside diameter, 40.5 mm inside diameter, 1309 mm total length, each of them with 50 pellets of 40.1 mm diameter and weighing 152 g. The total load requires 15,650 pellets weighing 2.379 kg. Nuclear grade ammonium diuranate was the starting material for the pellet fabrication. The fabrication process was thoroughly investigated in view of minimizing the operating costs. Through accurate control of the calcining, reduction and conditioning steps, a charge of high compactability has been obtained, which allows pellet production with the required density of 6.8 ± 0.2 g/cm^3 under compacting pressure of only 1.2 t/cm^2; these pellets are further sintered under Ar at a fast rate in an eight-zone, electrically heated, continuous sintering furnace. The reproducibility of the dimensions and density of the sintered pellets was found to be excellent. (auth)

38603 (A/CONF.28/P/492) RESEARCH REACTORS IN SPAIN. C. Sanchez del Rio (Spain. Junta de Energía Nuclear, Madrid), J. Montes, F. de la Cruz, G. Dominguez, J. C. de Zabalo, and J. J. Clua. May 1964. 20p.

There is now in Spain three Research Reactors: JEN-1 at the National Centre of Nuclear Energy in Madrid, ARGOS at the Technical School of Industrial Engineers in Barcelona and ARBI at the Technical School of Industrial Engineers in Bilbao. The first one is an American swimming pool type reactor working at a maximum power of 3 MW; it first became critical at the end of 1958. The other two are Argonaut type reactors, were constructed in Spain and went into operation at the middle of 1962. The activities of these reactors are described; including first, data concerning the organization of the reactors themselves and their relation with the centers where they are located. Among the activities of these reactors, the operation problems are briefly discussed. These problems were specially important at the beginning; afterwards the training activities of students were playing an important role in some of these reactors. The technical research was basically instrumentation tests, such as ionization chambers and other neutron detectors as well as the irradiation of some

fuel elements. One outstanding application of the swimming pool reactor was isotope production. Also interesting studies were accomplished using the activation analysis techniques. As far as pure research is concerned the reactors were used for neutron physics studies. The applications in the field of pure nuclear physics and solid state physics are also mentioned. (auth)

38604 (A/CONF.28/P/500) RECENT DEVELOPMENTS IN CONTROL AND SAFETY SYSTEMS FOR NUCLEAR REACTORS AT THE INSTITUTE OF NUCLEAR RESEARCH IN POLAND. P. Szulc and J. Podgórski (Polish Academy of Sciences. Inst. of Nuclear Research, Świerk). May 1964. 16p.

The control and safety systems of the ANNA critical assembly and the MARYLA low-power, swimming-pool reactor, both put into operation at the ŚWIERK Centre in 1963, as well as further developments in the control systems for nuclear reactors being designed at present in Poland are discussed. The ANNA critical assembly as a nuclear model of a high-flux research reactor of 20 to 30 Mw was equipped with a control system more ample than that which would be required usually for a critical assembly, in order to accumulate experience on its operation. This system consists of the following main measuring channels: pulse start-up channel controlling the reactor period in a 5-decade power range, current logarithmic channel controlling the reactor period in a 5-decade power range, current linear channel controlling the power-level in a two-decade range, and an automatic power-level regulation channel. The electronic equipment in that system contains special reliability-controlling circuits. In the linear channel a special comparative circuit with constant relative sensitivity independent from power-level was developed. The control and safety system of the MARYLA reactor consists of the following channels: current logarithmic channel, which controls the reactor period in about 7 decades for the 1 Mw to several kw power range, current linear multi-range channel covering a power-range from 50 Mw up to 1 kw. Two-step safety channel with adjustable trip-levels in a power range of hundreds watts up to several kw, with G.M. current counters as "gamma power" detectors. Logarithmic and linear channels serve to measure and secure the reactor period and power-level. The two-step safety channel plays a role of an additional "fuse." Its action shuts down the reactor by ejection of a fuel element section. The transistorized pulse start-up channel and automatic power-level regulation channel are in their design stage. The paper describes both control systems and the related electronic equipment, detectors, and control-rod drive mechanisms. At present, two new control and safety systems for 5- and 30-Mw research reactors are being developed. The new system of high structural reliability is being tested. The multipoint control high-speed-switch equipment for temperature and flow-rate measurements is in the design stage. (auth)

38605 (A/CONF.28/P/505) PORTUGUESE RESEARCH REACTOR. Antonio G. Ramalho (Portugal. Junta de Energia Nuclear. Laboratório de Física e Engenharia Nucleares, Sacavém). May 1964. 11p.

A detailed analysis is made of the existing programs for the utilization of the 1 Mw swimming-pool-type Portuguese Research Reactor (RPI) and of the means presently available or required to implement those programs. The advantages of promoting cooperation with universities and national or foreign research centers are discussed. The most relevant features of the reactor, which is similar to other well-known reactors of the same type, are described. A short summary analysis of the facility is made having in mind the experimental work which is in progress or planned. A summary of the results obtained during the calibration of the reactor is also presented. (auth)

38606 (A/CONF.28/P/517) EXPERIMENTAL STUDY OF FLOW INVERSION IN THE BELGIAN ENGINEERING TEST REACTOR BR2. G. Stiennon, K. J. Bobin, H. Dopchie, et al. (Centre d'Etude de l'Energie Nucleaire, Mol, Belgium). May 1964. 18p.

After a brief review of the Belgian high flux engineering test reactor (BR-2), tests made to determine the maximum safe operating power are described. These tests consisted essentially in the measurement of the temperature of the surface of the fuel elements, using thermocouples imbedded in the cladding, at different reactor powers, and then deliberately inducing all possible fault conditions; these included the total loss of coolant flow and loss of pressure in the primary circuit. Flux measurements were made in the core at the same time. During the tests, the maximum power attained was 37 Mw, giving a maximum heat flux of 600 w/cm^2 at the fuel element surface. This value is 1.5 times the planned operating figure, and is an exceptionally high value for this type of fuel element. The corresponding thermal neutron flux (energy above 0.5 ev) in the fuel plates was 10^{15} n cm^{-2} sec^{-1}. Even under these extreme conditions provided that pressure was maintained, the sudden loss of coolant followed by a flow inversion in the core did not lead to unacceptably high plate temperatures. The results both at steady power and during the different tests are analyzed. After determination of the time of the inversion, the maximum hot-spot temperatures in the fuel are calculated. The upper limit of specific power is then determined so that boiling does not occur even in the hottest channel. These data permit the safety assessment of this type of reactor at high specific powers and for different core configurations. (auth)

38607 (A/CONF.28/P/531) A REVIEW OF INVESTIGATIONS AND EXPERIMENTAL UTILIZATION OF THE RESEARCH REACTOR IN THE INSTITUTE OF NUCLEAR RESEARCH OF THE CZECHOSLOVAK ACADEMY OF SCIENCES. F. Musilek, F. Berger, L. David, Z. Hrdlicka, B. Stoces, J. Urbanec, and V. Zajic (Ceskoslovenska Akademie Ved. Ustav Jaderneho Vyzkumu, Rez). May 1964. 17p.

The report deals with the reactor use by scientific laboratories and with the works aimed at its improvement and development. The first part of the report, which is devoted to the reactor exploitation, contains a survey of all experimental work carried out in the fields of nuclear physics, reactor physics and nuclear technology. In the second part studies are reported on reactor physical characteristics as well as on the changes and improvements which were or will be performed in the reactor. In conclusion experience is summarized comprising the cooperation of the reactor laboratory with other scientific laboratories, experimental capacity of the VVR-S reactor as well as experimental work programming. (T.R.H.)

38608 (A/CONF.28/P/534) RESEARCH REACTORS IN THE FEDERAL REPUBLIC OF GERMANY. K. H. Beckurts (Kernforschungszentrum, Karlsruhe, Germany), N. Fiebiger, E. Fischer, L. Koester, T. Springer, K. Wirtz, and K. E. Zimen. May 1964. 20p.

A survey paper on the utilization of research reactors in the Federal Republic of Germany is given. The various low-energy critical and subcritical assemblies in use for reactor physics and engineering studies are not included in the survey. The paper includes a short technical

description of each reactor in tabular form and some additional information on major experimental facilities, such as loops, neutron spectrometers and other devices of special interest. Operational problems relevant to the utilization of the reactors are briefly discussed. Applications are described. (T.R.H.)

38609 (A/CONF.28/P/582) FIELD OBSERVATIONS OF ENVIRONMENTAL EXPOSURE DOSE FROM RADIO-ARGON CLOUDS. S. Sakagishi, T. Ishihara, and I. Miyanaga (Japan Atomic Energy Research Inst., Tokyo). May 1964. 20p.

Argon-41 produced in the air found in irradiating pockets of beam tubes is the only gaseous radioactive material produced during normal operation of certain types of reactors that can cause external exposure hazards to neighboring population. At the same time, this provides a good and effective tracer to determine experimentally diffusion patterns of gaseous waste into atmosphere. Field observations were undertaken to measure ^{41}Ar for the dual purpose of determining the environmental exposure dose by ^{41}Ar from several reactors, and for checking experimentally the dose estimation by Pasquill-Meade's method, which has been adopted as standard method of analysis for diffusion problems. The observations were carried out 4 times altogether in the period from 1961 to 1962, using JRR-2 which is an enriched uranium fueled heavy water reactor of 10 Mw. (auth)

38610 (A/CONF.28/P/615) PARAMETERS OF THE WWR-M REACTOR OF THE PHYSICS INSTITUTE OF THE UKRAINIAN ACADEMY OF SCIENCES AND ITS APPLICATION FOR THE NUCLEAR PHYSICS RESEARCH. M. V. Pasechnik, I. F. Barchuk, V. P. Vertebny, M. F. Vlasov, V. V. Koloty, A. N. Maistrenko, V. I. Mostovoi, M. M. Nazarchuk, D. T. Pilipets, and S. O. Slesarevskii (Akademiya Nauk Ukr. S.S.R. Fiziko-Tekhnicheskii Institut). May 1964. 16p.

The spatial distributions of thermal and fast neutron fluxes in the reactor channels are presented, and the methods by which they were measured are indicated. To increase the reactor power level, the core temperature conditions were studied; and a method was developed of fuel element leak testing. From the temperature measurements, the temperature distribution along the fuel element height and its change by the presence of the control and safety rods were obtained. An optimum coolant flow rate was found at different power levels. It was established that WWR-M reactor can be operated at the 12 Mw power level without any constructive alterations. A diagram and a description of a fuel element leak-testing set-up is given. Neutron spectrometry studies using time-of-flight technique are described, including measurements of neutron cross sections for separated isotopes. The cross-sections of ^{166}Er, ^{167}Er, ^{168}Er, ^{170}Er, ^{185}Re, and ^{187}Re were obtained for the thermal and resonance regions. Experiments on inelastic scattering of slow neutrons in moderators are briefly described, and some problems involving cold neutrons are considered. Total scattering cross-sections of liquid oxygen and nitrogen are given for wavelengths of 4 to 15 Å. (auth)

38611 (A/CONF.28/P/647) AUTOMATIC CONTROL OF THE AVERAGE CORE FLUX BY MEASURING N^{16} COOLANT ACTIVITY AT THE FRM MUNICH RESEARCH REACTOR. M. Sommer (Munich. Technische Hochschule). May 1964. 11p.

Stability of the neutron flux very often is a prerequisite for exact results of experiments using a reactor as a neutron source. Usually the flux is measured at the reflector of the core in order to control the total flux. As a result the flux at the chamber position is kept constant, but this leaves a possibility open for a variation of the average core flux by as much as 20%, caused by a change of the flux distribution in and around the core. To avoid this the average core flux of the FRM is kept constant by a cascade control system using ^{16}N coolant activity. The ^{16}N activity depends on the fission rate in the core and exceeds all the rest of the activities of the coolant by far. It may be determined independent of small variations about the mean value of the water flow rate. A suitable arrangement will be described where the ^{16}N activity depends only on the average core flux. The control circuits based on ^{16}N activity proved to be very successful, e.g., for intermittent reactor operation the variation of intensity of the P3 neutron beam always stayed below 1.8% over a period of several weeks, and for continuous operating at constant power of 1 Mw the variation is as low as 0.7% compared to former variations of 12% at the same beam tube. (auth)

38612 (A/CONF.28/P/666) NEUTRON FLUX MEASUREMENTS IN A POOL TYPE LIGHT WATER MODERATED RESEARCH REACTOR. B. Arad, G. Ben-David, E. Nardi, and M. Pasternak (Israel. Atomic Energy Commission, Tel-Aviv). May 1964. 19p.

Measurements of thermal, epithermal, and fast neutrons were carried out in the light water-moderated pool reactor IRR-1. The purpose of these experiments was: to evaluate the thermal and epithermal neutron fluxes inside the core and the adjacent experimental facilities; and to study the fast neutron spectral shape and its attenuation at various distances in the light water reflector. The results indicate a hardening of the spectrum at increasing distances from the core. A dip in the spectrum between 3 and 4.5 Mev was observed at larger distances from the core and a smaller dip in the same region adjacent to the core. A slight hardening was also noted in the in-core spectrum as compared with a pure fission spectrum. (auth)

38613 (A/CONF.28/P/670) A STUDY OF FAST-NEUTRON TRANSPORT IN WATER WITH A POOL-TYPE REACTOR. M. S. Bokhari and V. V. Verbinski (Oak Ridge National Lab., Tenn.). May 1964. 11p.

Measurements were made of the spectra of fast neutrons within the core of a pool-type reactor, at the core-shield interface and at various positions in the water with a shielded spectrometer. Distances varied to 60 cm along the normal to the reactor face and to 40 cm at 51 and 40.5° from the normal. The data obtained along the normal to the reactor face show a hardening of the spectrum with increased distances in water and the presence of dips in the spectrum corresponding to resonances in the oxygen total cross section at 1.3, 3.7, and 4.1 to 4.3 Mev. These dips essentially disappear, and the spectrum becomes softer at 51 and 41.5°. The data were compared with theoretical calculations. The shielded-diode spectrometer was described. (auth)

38614 (A/CONF.28/P/671) A REACTIVITY OSCILLATOR FOR SWIMMING-POOL REACTORS. M. Nuruddin Qazi (Pakistan. Atomic Energy Centre, Lahore). May 1964. 12p.

The development and testing of a very simple and reliable reactivity oscillator are described. Although it is particularly suited for swimming-pool reactors, it can be used with other similar types of reactors either in the present form or with slight modifications. Its chief advantage is the ease and convenience in setting up and performing the actual experiment of amplitude transfer function measurement. The

device is capable of providing an infinitely adjustable frequency range from 0.01 to over 100 c/s, which is achieved by using a variable speed d-c motor coupled with a specially designed system of pulleys. The need for a long rotor shaft was eliminated by the use of two selsyn servo motors. The reactivity oscillations were achieved by oscillating the amount of cadmium from a minimum to a maximum by rotating an aluminum disc carrying symmetrically placed cadmium sheets over another stationary aluminum disc exactly similar to the former. The resulting fluctuations in the neutron density of the core are detected by an ionization chamber and displayed on an oscilloscope. A polaroid camera is used to record these fluctuations from the oscilloscope screen. This apparatus was used to measure the amplitude transfer function of the Pennsylvania State University Reactor. The experimentally obtained amplitude transfer function plots were compared with those computed theoretically on IBM-7074 for various values of the prompt neutron lifetime. In computing the theoretical results, a value of 0.008 was used for the total effective fraction of the delayed neutrons —based on the experimental determination in BSR-1 at the Oak Ridge National Laboratory. The prompt neutron lifetime in the Pennsylvania State University Reactor was thus found to be 65 micro-seconds. (auth)

38615 (A/CONF.28/P/676) SUR LA CONSOMMATION DU COMBUSTIBLE DANS LE REACTEUR VVR-S IFA-BUCAREST. (Fuel Burnup in WWR-C Bucharest Reactor). I. Udrea, L. Mantescu, P. Popa, and D. Cepraga (Academia R.P.R. Institutul de Fizică Atomică, Bucharest). May 1964. 11p.

Fuel burnup is studied on groups of 16 rods, and is defined by the function $FA_i = -(f/k)/(\Sigma ai/\Sigma' ac)$ where Σai is the absorption cross section in the fission products and $\Sigma' ac$ is the total absorption cross section in the burned-up uranium. Variation of the factor η with burnup is neglected, and justification for this is given. The quantity of uranium-235 burned up, the absorption cross section of the fission products, and variation of the factor ηf with burnup are deduced from these functions as measured on the WWR-C reactor using the danger coefficient method. These values are compared with those deduced from the poisoning characteristic. (auth)

38616 (A/CONF.28/P/705) AN ANALYTICAL METHOD FOR NEUTRON THERMALIZATION CALCULATIONS IN HETEROGENEOUS REACTORS. J. Pop-Jordanov (Institut za Nuklearne Nauke "Boris Kidric," Belgrade). May 1964. 15p.

It is well known that the use of diffusion approximation for studying neutron thermalization in heterogeneous reactors may lead to considerable errors. On the other hand, exact non-diffusional methods, which are numerical and rather laborious, require the use of large digital computers. The use of diffusion approximation in absorbing media was avoided but the treatment remained analytical. This made possible a clearer insight into the physics of the phenomenon and a simpler way of practical calculations. The moderator is treated according to the heavy gas model, the slowing down in the fuel is neglected, and the angular distribution of neutrons at the fuel boundary is assumed to be isotropic. The non-Maxwellian factor of distribution in the moderator is expressed as a sum of an exact one-velocity solution and a series of Laguerre polynomials multiplied by Bessel functions. An energy dependent boundary condition on the fuel surface was determined by the neutron balance method without the use of diffusion approximation and the resulting formula was connected with corresponding escape probabilities whose energy dependence is determined from basic cross section data. The effects of using different escape probabilities were studied. Explicit formulas for calculating disadvantage factors of the fuel and the moderator, the mean neutron energy, and the neutron temperature, were derived. The convergency of the expansions was shown to be satisfactory. The method was adapted for practical calculations with different temperatures and different cylindrical fuel elements including claddings. To check the method, heavy water and graphite cells were calculated by using both the diffusional and the more exact methods with and without taking thermalization into account. The results of the proposed method have shown to be considerably more accurate than the diffusional ones, and they are in good agreement with Honeck's numerical and experimental results. The method was used for theoretical analysis of experiments on the Yugoslav RB reactor. (auth)

38617 (A/CONF.28/P/709) DETERMINATION OF THE TRITIUM BUILDUP IN A HEAVY-WATER-MODERATED REACTOR. Z. Matic-Vukmirovic, S. V. Ribnikar, Dj. Bek-Uzarov, Lj. Dobrilovic, M. Hadzisehovic, M. Ilic, I. Mocilnik, D. Paligoric, and J. Pop-Jordanov (Institut za Nuklearne Nauke "Boris Kidric," Belgrade). May 1964. 18p.

During the operation of reactors moderated with heavy water an amount of tritium is formed owing to the (n,γ) reaction on deuterium. The activity of tritium is supposed to be proportional to the total neutron flux received by the heavy water and to the amount of total energy produced by the nuclear fuel. However, the amount of tritium lost on account of deuterium produced by radiolysis is unknown. The RA reactor at Vinča, Yugoslavia, was the object of the investigations. Its conditions are as follows. Fuel: uranium containing 2% of ^{235}U; power: 6.5 Mw; mean neutron flux: 2.7×10^{13} n/cm^2 sec. The distribution of tritium between heavy water and hydrogen, which liberates radiolytically from it, was measured. It was found that the tritium content in hydrogen is 64 to 80% smaller than that of hydrogen in water, which depends on the reactor temperature (60–20°C). This fractionation can be explained by the equilibration of DT and D_2O molecules which was radiation catalysed. The buildup of tritium in the heavy water bulk was followed from December 1961 to November 1963. During this period the activity of tritium increased from 120 to 580 μc/ml D_2O. The liberated reactor energy calculated from the activity of tritium is in good agreement with the values obtained by thermal measurements. Accordingly, if the power history of the reactor and the mean neutron flux per unit power are known, the total neutron flux and the total energy released can be readily determined by measuring the activity of tritium. (auth)

38618 (A/CONF.28/P/718) PHYSICAL CHARACTERISTICS OF RESEARCH POOL-TYPE REACTOR IRT-2000 WITH TEST-LOOP CHANNEL. A. K. Krasin, V. A. Naumov, I. A. Savushkin, G. I. Strelkov, and O. I. Yaroshevich (Akademiya Nauk Belorusskoĭ S.S.R., Minsk). May 1964. 15p.

Calculated and experimental results on physical characteristics of the IRT-2000 research reactor (water-cooled and -moderated) are given. The influence of a recently installed test loop in the core on critical masses, neutron flux distributions, and excess reactivity was studied.(R. E. U.)

38619 (A/CONF.28/P/724) UTILIZATION OF THE HIGH FLUX REACTOR AT PETTEN. J. J. M. Snepvangers (Reactor Centrum Nederland, Petten), M. Grenon, H. Postma, and K. F. Maartman-Moe. May 1964. 16p.

The 20 Mw High Flux Reactor (H.F.R) is owned by the European Atomic Energy Community (Euratom), as part of its research establishment at Petten. The reactor is operated by the Netherlands nuclear energy organization, Reactor Centrum Nederland (R.C.N.), and used jointly by Euratom and R.C.N. Both parties co-operate with other organizations in the execution of experiments. As regards Euratom, these are mainly organizations in the other five countries of Euratom. R.C.N. carries out a number of experiments of its own, and also some in co-operation with the Norwegian Institutt for Atomenergi (I.F.A.). Other experiments are done by R.C.N. under contract. Some of the beamholes have been made available for nuclear physics experiments to University teams working under the auspices of the Netherlands' Organization for the Fundamental Investigation of Matter (F.O.M.). The organizational aspects of the use of the reactor are discussed and the more important experiments are described. Five of the horizontal beamtubes are at present used for neutron physics research. All of them are equipped with standard collimators. Two of the beams are used for neutron diffraction research, one utilizing polarized neutrons and the other one being equipped with a powder and a single crystal spectrometer. Two beamtubes are used for capture gamma ray experiments, and in one beam research on the inelastic scattering of thermal neutrons is carried out. The majority of the experiments in or near the fuel region of the core is of the so-called instrumented capsule-type, others are carried out in loops. The majority of these irradiation experiments aims at the investigation of non-fissile materials, a smaller number is for reactor fuel research. (auth)

38620 (A/CONF.28/P/725) THE BIOLOGICAL AGRICULTURAL REACTOR NETHERLANDS (BARN) DESIGN AND COMMISSIONING. M. Bogaardt, J. Coehoorn, W. Hofman, and W. W. Nijs (Reactor Centrum Nederland, The Hague). May 1964. 12p.

The "Biological Agricultural Reactor Netherlands" of the Institute for the Application of Atomic Science in Agriculture at Wageningen has been designed by Reactor Centrum Nederland and has been specially equipped for fundadamental and applied research in the agricultural and biological field. The BARN reactor, a modified swimming-pool-type with a power of 100 kw used as a source for thermal and fast neutrons for irradiations of both chronic and acute nature, is described. Irradiation facilities are described. (auth)

38621 (A/CONF.28/P/744) UTILIZATION OF RESEARCH REACTORS AT TROMBAY. R. Ramanna (India. Atomic Energy Establishment, Trombay). May 1964. 12p.

A description of the utilization of Apsara and Canada–India for studies in fission physics and chemistry, lattice dynamics, magnetic structure and crystallography, and neutron thermalization is given. These reactors were also used for studies in radiation damage, particularly to organic coolants. Other uses were for the production of short-lived isotopes for studies in nuclear spectroscopy. Work done using the Zerlina reactor for the study of lattice investigations using rod clusters is also described. (auth

38622 (A/CONF.28/P/747) THE PROGRAMS FOR UTILIZATION OF THE RESEARCH REACTOR TR-1 AT THE CEKMECE NUCLEAR CENTER. Sait Akpinar (Turkey. Atomic Energy Commission. Cekmece Nuclear Research Center, Istanbul). May 1964. 17p.

The research and training programs for the TR-1 reactor are reviewed. The pool-type reactor is rated at 1 Mw and uses 90% enrichment. (R.E.U.)

38623 (A/CONF.28/P/790) RELEASE OF FISSION GASES IN REACTOR COOLANTS UNDER NORMAL OPERATIONS. K. G. Vohra (India. Atomic Energy Establishment, Trombay). May 1964. 16p.

Measurements of fission gases and their daughter products in the coolant and in the atmospheric air in a swimming-pool reactor have established the proposed mechanism of diffusion in which the degree of release of fission gases would depend on the nature and composition of the fuel, its temperature and surface area, the geometry of the fuel element, and the coefficient of diffusion. The proposed model can be used for the calculation of release of fission gases in reactors of different types under normal operation. (auth)

38624 (A/CONF.28/P/793) PRIMARY COOLING WATER SYSTEM CHARACTERISTICS UNDER TRANSIENT CONDITIONS—CANADA INDIA REACTOR. V. Surya Rao, N. Veeraraghavan, M. S. R. Sarma, G. G. Joshi, and M. Sampathkumaran (India. Atomic Energy Establishment, Trombay). May 1964. 12p.

The primary cooling system of CIR is designed for recirculation with a normal flow rate of 4200 IGPM. Any shut down of the primary pumps results in a reactor scram, whereby recirculation is converted to a one-pass gravity feed emergency system with a flow rate of 1200 IGPM achieved in 8 seconds. During commissioning, a number of tests were conducted to determine system flow and pressure behavior in the change-over period from normal recirculation to a one-pass system. The experimental flow coast-down data were in general agreement with the predicted hydrodynamic characteristics of the system, though flow and pressure oscillations were observed. A computer program was written to calculate the aluminum cladding and bulk coolant temperatures (in the change-over period) along the fuel rod, using theoretical flow coast-down and power decay data. The computer was also programmed to estimate coolant saturation temperatures and to detect any boiling under the conditions. When the flow and pressure oscillations that were observed in the commissioning tests were superimposed on the computer results, the uncertainty was so great that unsafe conditions of nucleate and/or bulk boiling appeared possible. Several modifications to the cooling system for improved flow rates and pressures during change-over period were considered. Flow coast-down tests were repeated to assess reproducibility of earlier results. At the same time, experimental measurements of coolant temperature transients at fuel rod exit were made under intermediate reactor power operating conditions to assess accuracy of computer predictions. No pressure and flow oscillations were observed during these and subsequent flow coast-down tests. Observed temperatures being consistently much lower than predicted values, it was clear that there was no risk of the aluminum cladding of the fuel rod melting or the phase transition temperature for uranium being reached. Nevertheless, the observed temperatures indicated nucleate boiling for 40-Mw operation. It was thus concluded that reactor operation at 40 Mw called for certain modifications to the primary cooling system. Improvement in the hydrodynamic characteristics of the system was effected by installing fly-wheels on each of the primary coolant pumps, and flow coast-down tests repeated. A computer program with these data indicated the absence of boiling of any kind in fuel rods for a reactor power with individual fuel rod output not exceeding 330 kw. Only slight nucleate boiling was observed at fuel rod outputs of 375 kw. Further experimental measurements of temperature transients for cladding and exit water indi-

cated little or no rise from normal equilibrium values for fuel rods under high power operating conditions, during the change-over period following pump shut down. As experimental values and computer analysis firmly established that there were no hazards involved in operating the reactor at high power, the reactor power was raised to the full design value of 40 Mw and operated satisfactorily. (auth)

38625 (A/CONF.28/P/800) DOUBLE REACTOR CONTAINMENT FOR A CIRCULATING LIQUID FUEL REACTOR AND SITE REQUIREMENTS. H. Wijker (Keuring van Electrotechnische Materialen, N. V., Arnhem, Netherlands). May 1964. 15p.

The 250-kw KEMA Suspension Test Reactor, a circulating liquid fuel reactor, is under construction on the KEMA-grounds near Arnhem, the Netherlands. The principle of double reactor containment is applied to meet site requirements concerning dose limits at zone boundaries. The reactor system (first barrier between the suspension and the outer atmosphere) is placed in steel compartments, backed up by the concrete of the biological shield (second barrier, first reactor containment), which in turn are placed in a concrete reactor hall (third barrier, second reactor containment). The contingent release of radioactive gases to the environment is considered for 4 cases, viz., normal operation, maintenance, a major accident, and a hypothetical accident. The maximum concentration of radioactivity in the gases discharged from the 25-m high stack is set by the authorities to be 10^{-7} C/m^3 for design purposes. To maintain the underpressure in the nitrogen-filled compartments during normal operation, gases are discharged through the stack via charcoal adsorption beds for delay, and will always pass absolute filters and iodine traps. For maintenance purposes after shut-down of the reactor the compartments have to be opened. Beforehand they have to be practically free of radioactive gases that might have leaked from the reactor system. This is achieved by a combination of decay and purging. To complete this within reasonable time the concentration of radioactivity in the stack effluent has to exceed 10^{-7} C/m^3 for short times. This concentration will not reach the value of 10^{-4} C/m^3, being the limit at which the values in the stack and the ventilation inlet duct will close automatically. In the case of a major accident (release of the reactor content into the intact compartments) this limit is reached and the valves are closed. The arguments that the integrity of the first containment remains intact are discussed. Decay and controlled release via an emergency charcoal adsorption bed make it possible to remove practically all of the radioactive gases from the compartments in about 3 months without violating the site requirements. Even for a hypothetical accident in which all fission gases (700 kC) are released into the reactor hall, the site requirements can be met. To show this, one of the points to be considered is the meteorological dilution between the stack and the dose receptor. Due to the small distances to inhabited regions, also the concentration of radioactivity above ground level has to be considered. For a vertical plane through the stack and the wind direction a graph, based on Sutton's formula, was constructed to locate the point of maximum concentration in these inhabited regions. (auth)

38626 (A/CONF.28/P/807) CRITICAL AND EXPONENTIAL ASSEMBLIES AT THE INSTITUTE OF NUCLEAR RESEARCH—SWIERK. L. Adamski, Z. Bajbor, W. Dabek, J. Kozieł, and W. Suwalski (Polish Academy of Sciences. Inst. of Nuclear Research, Swierk). May 1964. 19p.

The zero-power swimming pool reactor MARYLA, the graphite- and water-moderated critical assembly ANNA, and the natural uranium–graphite exponential assembly HELENA are briefly described, together with the research program planned for the three facilities. Measurements of the physical characteristics of the three assemblies are also summarized. (D.C.W.)

38627 (IDO-24459) ADVANCED TEST REACTOR TURBO REPORT. Robert A. Turner (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). Jan. 1964. For Ebasco Services, Inc., New York. Contract AT(10-1)-1075. 46p. (S-R-133)

The time-dependent behavior of the Advanced Test Reactor was calculated on the Philco 2000 computer, using the Turbo depletion program. The fuel-and-boron loading used in this study gave the desired 17 full power days of operation while using a maximum amount of movable control. The controls were adjusted throughout the lifetime so that the deviation was less than ±4% from the desired 60-50-40 Mw power split. In addition, the experiment performance requirements were achieved in all but the A-3 experiment. The maximum ratio of the peak-to-average core power, 2.52, occurred in Element F-39. The power-peaking factors were calculated at various time steps by imposing a Maxwellian spectrum on the burnout shape generated by the Wigner-Wilkins spectrum; these factors were not corrected, however, for the axial peaking effect. (auth)

38628 (ORNL-3643) DEVELOPMENT OF THE ASSEMBLY METHOD FOR FUEL ELEMENTS FOR THE ADVANCED TEST REACTOR. R. W. Knight and C. F. Leitten, Jr. (Oak Ridge National Lab., Tenn.). Aug. 1964. Contract W-7405-eng-26. 83p.

A production procedure was developed for assembling fuel elements within the required dimensional tolerances for the Advanced Test Reactor. In the wedge-shaped element, 19 fuel plates of different width and curvature are joined to two side plates. Roll swaging was chosen over brazing, welding, and peening for joining the fuel plates to the side plates. To achieve adequate control of joining pressure, a new and unique air-operated roll swager was built and successfully used. The optimum joining force was 318 lb. Grooves to receive the fuel plates in the side plates should be 0.005 to 0.007 in. wider than the fuel plate thickness. The groove depth should be 0.100 in. for the thicker outer plates and 0.070 in. for the 17 inner plates. Procedures for assembly and inspection of the elements are described along with the dimensional tolerances achieved in the finished elements. (auth)

38629 LES TRAVAUX DE LA CONFÉRENCE INTERNATIONALE DE PHYSIQUE ET DE TECHNIQUE DES RÉACTEURS NUCLÉAIRES DE RECHERCHE, BUCAREST, LES 10-17 NOVEMBRE 1961. (The International Conference on Physics and the Technique of Nuclear Research Reactors, Bucharest, Nov. 10-17, 1961). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 1-724(1961).

Abstracts are given for 58 papers delivered at the conference. Six of the papers are abstracted in NSA as 16: 34119 and 24772; 17: 7059, 7060, and 7061; and 18: 17281. (T.R.H.)

For abstracts of individual papers see: 37529, 37530, 37531, 37532, 37533, 37534, 38057, 38058, 38059, 38242, 38346, 38544, 38630, 38631, 38632, 38633, 38634, 38635, 38636, 38637, 38638, 38639, 38640, 38641, 38642, 38643, 38644, 38645, 38646, 38647, 38648, 38649, 38650, 38651, 38652, 38653, 38654, 38655, 38656, 38657, 38658, 38659, 38660, 38661, 38662, 38663, 38664, 38665, 38666, 38667, 38668, 38669, 38670, 38671, 38672, 38673, 38674, and 38675.

38630 NEUTRON SPECTRUM CALCULATIONS OF THE VVR-S AND IRT REACTORS. Yu. G. Nikolaev and D. F. Davidenko (Kurchatov Inst. of Atomic Energy, Academy of Sciences, USSR). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 25-35(1961). (In Russian)

The first neutron flux measurements in the reactor core by means of neutron threshold detectors yielded only approximate values; most of the data were obtained by calculation. The problem involves the determination of the fast and slow neutron fluxes in a given homogeneous mixture of nuclei which fill up an infinite space containing a constant-intensity fast neutron source. The structure of the VVR-S and IRT reactors makes it possible to solve the problem by using the same methods as in the case of homogeneous reactors. In view of the large fast-neutron leakage of about 25%, a correction must be introduced in the infinite space flux calculations. The computer program developed for this purpose has been reported previously. The program made it possible to solve an integral equation system for a mixture containing up to 5 elements. The collision densities and neutron fluxes were calculated in 361 points in the lethargy scale, covering the complete fast and slow neutron range of the reactors in question. The program requires that one of the 5 elements must be H, and specifies the atomic range of the others. Moderation by elastic scattering on elements with an atomic weight larger than 80 was neglected in the calculations. In view of the absence of sufficient experimental data, the anisotropy of the elastic scattering on H and Al nuclei were not taken into account. The fission spectrum of ^{235}U was used as the fast-neutron source. The core of the 2 reactors was examined when loaded with 36 operating assemblies when the core has the shape of a regular paralleliped with a width and length of 43 cm and a height of 50 cm. The calculations showed that the reactors have an epithermal flux of $8.5 \cdot 10^{13}$ n/cm^2 · sec. (TTT)

38631 ON LOCAL MODIFICATION OF THE NEUTRON SPECTRUM IN THE INTERNAL THERMAL COLUMNS AT THE VVR-S REACTOR. H. Hulubei, I. Purica, T. Rosescu, and M. Sabau. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 37-42(1961).

An analysis is presented of means of modifying the neutron flux of reactor thermal columns to increase thermal neutron flux. The use of moderating cylinders of infinite length is treated. The results are compared with experiments carried out in the IFA-Bucharest reactor. Methods for reducing lattice perturbations caused by introducing a thermal column are discussed. (T.R.H.)

38632 NOISE MEASUREMENT IN THE RFR. P. Liewers and G. Huettel (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 79-86(1961). (In German)

The theoretical bases for reactor noise are reviewed, and an equation is developed:

$$\frac{\langle|\Delta i|^2\rangle}{(\Delta i)^2} = \frac{\langle|\Delta u_g|^2\rangle}{|R(\omega)|^2\,(\Delta i)^2}\,\Delta L = D + E\,A^2(\omega)$$

D and E are constants dependent on reactor parameters, and ΔL is the change in reactor power in watts. The chamber currents (i) are measured by galvanometer. $|R(\omega)|^2$ is a correction factor for chamber-cable capacity. The noise potentials $\langle|u|^2\rangle$ are measured by an arrangement described. Experimental results obtained are given and discussed. An error of about $\pm 2.5 \times 10^{-5}$ s is reported. (T.R.H.)

38633 EXAMINATION OF THE FUEL ELEMENTS OF THE HEAVY-WATER RESEARCH REACTOR OF THE CHINESE ACADEMY OF SCIENCES. Chi Sun and Tszyun-chan Van. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 87-90(1961). (In Russian)

In order to study the dependence of the deformation of the fuel elements on the burnout and to estimate their useful service life, an operational unit was removed from the reactor core. The unit was cut and its internal dimensions were carefully measured. The unit contained 11 circular fuel elements with a 37-mm external and 29.5-mm internal diameter, coated with an 0.8-mm thick Al alloy layer. U with an enrichment of 2% was used as fuel material. At the time of the removal, the 11 fuel elements in that channel reached an average of 7.1% and a maximum of 9.4% burnout. Examination of the cut elements revealed the presence of a homogeneous yellow layer on the surface; this was found to be anodized Al film. No cracks or dents were found on the surface of the elements. Black deposits and spots were also noticed on some of the elements; they might have been caused by corrosion. In spite of this, the coating was considered as perfect. The dimensional measurements indicated that the deformation depends on the burnout. The largest noted dimensional increase did not exceed 0.16 mm. (TTT)

38634 USE OF A CONVERTER IN A NUCLEAR REACTOR FOR THE TRANSFORMATION OF THE NEUTRON SPECTRUM. V. S. Dikarev. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 103-6(1961). (In Russian)

The experimental use of slow-neutron reactors, such as the VVR-S and the IRT-1000 neutron sources could be broadened considerably by employing converters to transform the neutron spectrum of the reactor into a fission spectrum. A U plate irradiated by thermal neutrons produces the fission spectrum. A large converter was installed in the VVR-2 reactor for the purpose of studying the thermalization of the neutrons, using a series of moderators placed at various distances from the fission-neutron source. The converter consisted of 500-mm high and 400-mm wide natural U blocks placed in an Al container; the heat generated was removed by circulating water. The space between the U blocks was filled with boron carbide rods which absorbed the moderated neutrons; thus, the emerging spectrum was very close to the fission spectrum. When the reactor was operated at the 2000-kw level, about 50 kw was released in the converter at a cooling-water flow rate of 7 m^3/hr and a U temperature of 70°. The spectrum was determined by the time-of-flight method, using a chopper and a time analyzer. Comparison of the spectrum with that of the VVR-2 reactor showed that the converter spectrum was greatly enriched in fast and resonance neutrons. As a result of the absorption of the neutrons in the converter, the shape of the thermal portion of the spectrum differed from the equilibrium Maxwellian distribution. (TTT)

38635 POSSIBLE METHODS FOR INCREASING LOCALLY THE IRRADIATING POWER OF THE VVR-S REACTOR. Ya. Pfann. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 107-17(1961). (In Russian)

There are 2 possible methods for increasing the neutron flux in the VVR-S reactor for the purpose of preparing radioactive isotopes or for experimental reasons: increase of the power level of the reactor and the use of an internal reflector or neutron trap. The second method was used. Its application results only in a localized increase of the thermal neutrons while the fast flux is actually decreased. Calculations, later confirmed by actual experiments, have shown that such a trap is indeed useful to increase the thermal neutron flux of the VVR-S reactor. Ordinary water was found to be the most suitable material for the neutron trap. Light water did not present any operational problems;

under optimum conditions, the thermal-neutron flux was increased threefold. The enclosed absorber had no practical effect on the optimum diameter of 13.0 cm. The specific heat transfer from the fuel elements at the boundary was increased by about 60% when 1 unit was installed and by 70% in the case of 4 units. Creation of a moderator-filled cavity resulted in an increase of the fuel loading at the boundary region. When the reactor is operated with the trap, the flow of the cooling water must be stopped in order to avoid the possibility of overheating the surrounding fuel elements. (TTT)

38636 THE OPTIMUM UTILIZATION OF THE INTERNAL THERMAL COLUMNS FOR PRODUCING HIGH SPECIFIC-ACTIVITY RADIOISOTOPES. I. Purică, T. Roşescu, M. Sabău, D. Stoian, G. Fodor, and C. Chiotan. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 119-23(1961). (In Russian)

The neutron spectrum of the VVR-S and IRT type water-cooled, water-moderated, enriched-U reactors includes a large portion of fast and epithermal neutrons which can be transformed into thermal neutrons by means of internal thermal columns. Such a column was built into the VVR-S-type reactor of the Institute of Atomic Physics at Bucharest. The equivalent diameter of the column is equal to 8.1 cm while the effective diameter of the blocks used for irradiation is 2.2 cm; they are handled by means of manipulators. Water flowing at the rate of 1.7 m^3/hr, i.e., with a velocity of 0.14 m/sec through the column cools the blocks during the irradiation; at that flow rate 33.7 cal/$cm^2 \cdot hr \cdot °C$ heat is dissipated in the system. The hydraulic resistance of the thermal column prevents interference with cooling of the fuel elements surrounding the column. The theoretical calculations were verified by experiments carried out with ^{32}P, ^{60}Co, ^{185}W, ^{198}Au, and ^{131}I, irradiating simultaneously identical samples in the thermal column and in the usual beamhole, measuring subsequently the activities obtained by β-counting. Running the reactor at 2000 kw, the specific activities obtained in the thermal column were found to be 3 times higher than in the beamhole. The column is therefore considered suitable for the preparation of high-activity radioisotopes. (TTT)

38637 γ-RADIATION AND NEUTRON SPECTRA FROM THE HORIZONTAL BEAMHOLE OF THE VVR-M REACTOR OF THE UKRAINIAN ACADEMY OF SCIENCES. M. V. Pasechnik, I. F. Barchuk, G. V. Belykh, V. I. Golyshkin, A. F. Ogorodnik, V. P. Vertebnyi, M. F. Vlasov, V. V. Kolotyi, and A. N. Maistrenko. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 127-34(1961). (In Russian)

A special apparatus was installed in the VVR-M reactor of the Ukrainian Academy of Sciences for studying the interaction of neutrons with atomic nuclei. The γ-spectra were determined by means of a magnetic Compton γ-spectrometer possessing a nonhomogeneous magnetic field and focusing the recoil electrons at an angle of 180°. The recoil electrons with an E > 0.5 Mev were recorded by 3 gas-discharge type coincidence counters. The spectra contained the lines of all the elements present in the structural materials of the core. Interaction of slow neutrons with the atomic nuclei in the horizontal beamhole of the reactor was investigated by means of a mechanical chopper, similar to the one described in Paper P/2152 at the Second Geneva Conference in 1958, operating within the range from 100 to 10,000 rpm. A set of $^{10}BF_3$ counters was used to detect the neutrons, while the time of flight was determined with a channel analyzer having channel widths of 0.5, 1, 2, 4, 8, 16, 32 and 64 microsec and a dead time of 16 microsec. The slow-neutron spectrum of the horizontal beamhole was measured by operating the chopper at 243 rpm with a resolution of 4.8 microsec/m. The temperature of the neutron gas in the beam was found to be close to the core temperature. The fast neutron spectrum was determined by means of a 200-micron-thick nuclear emulsion on the basis of the scattering of the fast neutrons by the H of the emulsion which thus acts as a radiator and a detector of recoil protons. Tracks with a scattering angle of less than 10° were examined. It was found that the fast neutron spectrum does not represent a pure ^{235}U fission spectrum because of the distortion caused by the photoneutrons of Be. (TTT)

38638 NEUTRON SPECTRUM TEMPERATURE DISTRIBUTION MEASUREMENTS IN THE VVR-S REACTOR CORE. T. Rzeszot and E. Warda. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 135-41(1961).

Using the boron filter method, the distribution of the neutron spectrum temperature along the vertical axis of the VVR-S reactor core was measured. An Al tube replaced one of the 43 fuel subassemblies. A Cd collimator was placed in the tube and boron and paraffin blocks were arranged above. The neutron beam at various levels was obtained by changing the water level in the tube. The method is very sensitive giving a temperature resolution of about 4°K. Reproducibility was good. (T.R.H.)

38639 SOFT GAMMA RAY SPECTRUM FROM VVR-S REACTOR. V. Cojocaru and M. Cristu. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 143-6(1961).

The gamma spectrum below 3 Mev was measured for the VVR-S enriched-fuel light-water-moderated reactor. A gamma spectrometer with NaI(Tl) crystal 40 × 40 mm and FEU-29 photomultiplier was used. Energy resolution was about 10% for the 662-kev gamma from ^{137}Cs. Spectra from unoperated and operated reactor are shown. (T.R.H.)

38640 ON THE EXPERIMENTAL DETERMINATION OF THE NEUTRON TEMPERATURE IN THE ACTIVE ZONE OF THE RFR WITH ACTIVATION PROBE. D. Albert (Zentralinstitut fur Kernphysik, Rossendorf, Ger.). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 147-54(1961). (In German)

Materials were chosen for the activation probes with widely differing cross sections. They were ^{176}Lu of ^{151}Eu, and ^{235}U and ^{239}Pu for fission probes, the Lu and Eu being of natural isotopic composition, the ^{239}Pu was pure, and the ^{235}U was 36% enriched. Chloride solutions were prepared and dropped onto Ni and Al plates and fixed with varnish. The experimental arrangement is described in some detail. Neglecting epithermal activation, the average of 3 series of measurements of cross-section ratio was 1.27 ± 0.03 for Pu and U and for 1 measurement with Lu and Eu, 1.24 ± 0.03. Neutron temperatures obtained were $T_{Pu,U}$ = (420 ± 25)°K and $T_{Lu,Eu}$ = (375 ± 40)°K. (T.R.H.)

38641 THE CORRELATION BETWEEN FUEL EXPOSURE AND THE NEUTRON SPECTRA IN THE VVR-S REACTOR. Al. Ştefănescu. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 155-61(1961).

A study was made of the Cd ratio and the resonance integral relative to Au to show neutron spectra changes with burnup. A quantitative and a qualitative variation were found and discussed. (T.R.H.)

38642 SEVERAL DEFINITIONS OF THE EFFECTIVE TEMPERATURE OF NEUTRONS. Zbigniew Weiss. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 163-9 (1961).

Four definitions of effective temperature of neutrons are given and discussed. (T.R.H.)

38643 CALCULATION OF THE ACTIVATION OF FOILS IN THE THERMAL AND RESONANCE NEUTRON BEAM AND FIELD. M. Vorisek and D. Babala. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 171-87 (1961). (In Russian)

In view of the importance of the activation method for measuring the neutron flux and other reactor parameters, the fundamental calculations involved in the calculation of foils were examined. The usual corrections were not taken into consideration as that problem is reviewed in the following article. The calculations were based on the assumption that a homogeneous neutron beam with a known spectrum falls perpendicularly on the surface of the foil, whereby the scattering is negligibly small in comparison with the absorption. The values of ψ_{th} and ψ_r, the probabilities of the passage of thermal and resonance neutrons, respectively, were determined for D_2O and C reactors on one hand and for H_2O reactors with enriched fuel, on the other. The approximation formula derived yielded a markedly less precise value for ψ_r, than the value obtained with Au. In the case of activation in a neutron field, the diffusion approximation was used, neglecting the distortion of the field, the effect of finite dimensions of the foil and the internal scattering. The actual values for Dy, In and Cd were obtained by numerical integration. (TTT)

38644 CALCULATION AND MEASUREMENT OF CERTAIN CORRECTIONS IN THE CASE OF ACTIVATION BY THERMAL NEUTRONS. D. Babala and M. Vorisek. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 189-205(1961). (In Russian)

The corrections that must be taken into account when carrying out activation measurements include those which depend on the conditions involved in the activation process and those which arise from the measurement of the induced activity. Corrections which belong to the first group include the distortion of the thermal neutron field, interaction with the foil and the influence of the location of the foil near the boundary with the vacuum. Throughout the calculation it was assumed that the spatial distribution of the thermal neutrons may be expressed by the first two members of the diffusion approximation and that the spectrum does not depend on the location within the medium. Every detector, the properties of which differ from those of the medium, causes a distortion in the spatial distribution of the neutrons, and to a lesser extent, in their spectrum and their angular distribution. Measurements were made in the thermal column of the VVR-S reactor, using 0.2, 0.5 and 1-cm diameter Au foils and 0.2, 0.5 and 1.5-cm diameter In foils. As the Cd ratio was quite high, the correction due to resonance neutrons did not exceed 0.7%. The induced activity was measured by a NaI(Tl) scintillation spectrometer and a single-channel amplitude analyzer. A 1-mm thick Al foil was used to eliminate the effect of the β-radiation. The effect of the interaction was measured by means of an In foil. (TTT)

38645 STRUCTURAL CHANGES IN THE VVR-M REACTOR OF THE PHYSICO-TECHNICAL INSTITUTE. K. A. Konoplev (Ioffe Inst. of Physics and Tech., Leningrad). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 255-61(1961). (In Russian)

During the period of construction and after the startup, from 1959 to May 1961, the VVR-M reactor was considerably modified. Before full power level was reached, hydraulic changes were made, replacing the mechanical filter. A choke-valve was installed in the piping through which the heat transfer agent was flowing into the reactor vessel; this allowed reduction of the pressure and the flow rate in the primary loop. A similar valve was installed also in the de-aerator circuit. The ion-exchange system was provided with a stainless steel filter. The water pressure in the secondary loop of the heat exchanger must always be higher than in the primary loop; in order to achieve this, a choke valve was installed in the collector after the heat exchanger; in addition, a more reliable control panel was placed in the secondary system. Improvements were also made in the device used for the removal of irradiated containers from the reactor. In order to provide for better experimental facilities, 2 vertical channels were placed directly in the core, rather than in the reflector. The new remotely operated periscope and mirror system makes it possible to view the whole reactor vessel, including the upper cover. The new Pb plugs on the ducts leading to the core prevent activation of the upper shield. The temperature of the concrete in the biological and thermal shields are now controlled by thermocouples. Changes were made also in the choice and positioning of the ionization chambers. (TTT)

38646 VOID COEFFICIENT MEASUREMENTS IN "EWA" REACTOR. M. Czerniewski, W. Dabek, T. Rzeszot, and E. Warda. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 265-6(1961).

Void coefficients for experimental purposes were determined in the EWA reactor. Six water-filled aluminum containers 12 mm by 680 mm, 2 mm thick were inserted in the 4/22 fuel assembly. With the reactor compensated at 10 W power level, the containers were emptied and the position of the compensating rod recorded. This was done 3 days after shutdown. The average value was −0.32 pcm/cm^3 void. For precision calibration, the assumed value of β was 0.75%. (T.R.H.)

38647 CALCULATION OF A CYLINDRICAL REACTOR COMPLETELY SURROUNDED BY A REFLECTOR BY USING AN ORTHOGONAL SERIES WITH A SPECIAL METRIC. J. Cermak (Inst. of Nuclear Investigations, Prague). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 281-7(1961). (In Russian)

Calculation of the efficiency of a reflector surrounding the side and one or both ends of a cylindrical reactor presents difficulties. In order to overcome them, a new calculation method was worked out on the basis of a generalized Fourier series, starting from the one-group theory. The neutron flux density was determined on the basis of this approximation. The usual supplementary conditions were applied: disappearance of the neutron flux at the extrapolation boundary; continuity of the fluxes at the differential boundary. It was attempted to determine the value of B^2, the so-called geometric parameter; after that, the value of the Fourier coefficients may be computed and with their help the approximate neutron flux density may be obtained. The problem may be simplified by solving the simpler problem, involving only a lateral reflector. By means of this method the flux density distribution may be conveniently estimated. Again, considering a case with a lateral reflector only with reference to a reactor with a height of 100 cm, the formulas derived lead one to expect a large value for the parameter B^2; indeed, the calculation yielded a value of $B^2 = 7.363 \times 10^{-4}$ cm^{-2}. The method may be used equally when only one of the ends of the cylinder are covered with a reflector. (TTT)

38648 CALCULATION OF THE STATIONARY HEAT CONDUCTIVITY IN AXIALLY SYMMETRICAL ELEMENTARY CELLS OF HETEROGENEOUS REACTORS. G. Németi, K. Rászl, L. Szabados, L. Szegoe, and A. Toeroek (Central Physical Inst., Budapest). Rev. Phys., Acad.

Rep. Populaire Roumaine, 6: Suppl., 293-308(1961). (In Russian)

In order to operate a reactor efficiently, the heat transfer phenomena in the core must be known with accuracy. The surface of the fuel elements of currently used reactors release heat at a rate of several million kcal/m^2 hr. In order to understand the heat transfer relationships, a solution was derived for the differential equation of the heat conductivity, satisfying the third-order boundary conditions; this solution applies to axially symmetrical elementary cells with a finite length. The Fourier coefficients of the infinite series used for the solution were determined by an equation system containing an infinite number of unknowns. The temperature drop between the fuel and its cladding was taken into account in the calculation; the contact thermal resistance between the elements and their cladding, expressed by a fictitious heat transfer coefficient α is usually determined experimentally. In order to simplify the calculations, it was assumed that no heat is transferred through the ends of the elements; the thermophysical parameters of the fuel, cladding and coolant are temperature-independent, the coefficient α is constant throughout the cell and no heat transfer takes place between neighboring cells. A partial solution of Poisson's equation and a general solution of a Laplace equation were derived in order to solve this problem. In order to present a practical example, the heat transfer in an elementary cell of a VVR-S type reactor was calculated. (TTT)

38649 CRITICAL EXPERIMENTS WITH THE EXPERIMENTAL FACILITY OF THE VVR-M REACTOR. K. A. Konoplev, R. G. Pikulik, L. I. Rusinov, V. A. Solov'ev, and V. A. Shustov (Ioffe Inst. of Physics and Tech., Moscow). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 323-86(1961). (In Russian)

The critical experiments carried out on the experimental facility of the VVR-M reactor during the period from December 1959 to June 1960 were interrupted during the startup operations and were terminated before the reactor was brought to full power. The critical assembly was placed in a 1240-mm diameter and 1000-mm high water-filled Al container, representing a mock-up of the reactor core. The auxiliary equipment made it possible to load manually the fuel elements, spacers, reflector blocks and specimens. The flux distribution was measured by foils attached to the assembly at various locations. The core could be poisoned by means of uniformly distributed absorbers. Remote manipulators allowed removal of the source from the core. Boron carbide rods were used for emergency shutdown. For tests involving the determination of the critical mass, the reflector channels were filled with water. Criticality was reached by loading the system with 51 fuel elements, corresponding to 1360 g of ^{235}U. The $\Delta k/k$ value of the rods was estimated at about 6%; the efficiency of the 24.5-mm diameter steel rods was about 0.9%. The reserve reactivity of the system was assumed to be the sum of the efficiency of the individual rods, checking the calibration by poisoning the system, loading the core uniformly with rods of known cross section. The epithermal flux was measured by the activation of a Au foil in Cd. Details of loading and flux distribution of a number of experiments carried out with the facility are given. (TTT)

38650 WATER MODERATED CRITICAL SYSTEM TYPE ZR-1. Z. Gyimesi, F. Szabo, E. Zobor, E. Foti, L. Turi, and L. Muzsnay (Central Research Inst. for Physics, Budapest). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 387-401(1961). (In German)

The ZR-1 critical assembly is described and discussed. It is designed for study of reactor physical parameters using enriched uranium in water moderated and reflected zones. With a small auxiliary device, organic moderated zones can be studied. Safety problems are discussed. (T.R.H.)

38651 INVESTIGATIONS ON THE ZR-1 CRITICAL ASSEMBLY. F. Szabo, Z. Gyimesi, T. Barta, L. Turi, and J. Vigassy (Central Research Inst. for Physics, Budapest). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 403-14(1961).

A summary is presented of the results of measurements made on the ZR-1 critical assembly. The purpose of the measurements was to provide a basis for research on organic moderators. Critical masses for various $H/^{235}U$ ratios were determined directly. Flux distributions were measured in various lattices, and the temperature dependence of reactivity in various lattices was investigated. (T.R.H.)

38652 GRAPHITE EXPONENTIAL ASSEMBLY. T. Rzeszot, E. Warda, H. Markovic, and S. Takac. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 415-22 (1961).

An exponential assembly is described, and buckling and diffusion length measurements with it are reported. The device consists of a graphite cube 240 cm on a side with 100 fuel channels 60 × 60 mm, lattice constant 240 mm, and 26 measurement channels 30 × 30 mm. The cube is covered with cadmium foil. There is 2088 kg of natural U in rods 27.2 × 300 mm in a can 1-mm thick. The value of L obtained is 48.4 cm. From the buckling experiment the dimension of a cubic critical reactor is 734 ± 14 cm. (T.R.H.)

38653 SUBCRITICAL ASSEMBLY FOR INVESTIGATION OF REACTOR PHYSICS. I. Purika, T. Roshesku, M. Sabzu, G. Fodor, V. Ieremiya, P. Dzheordzhesku, K. Karageorgiev, and M. Pavelesku. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 423-30(1961). (In Russian)

The design of an enriched-uranium, graphite-moderated subcritical assembly is presented. Measurements of the multiplication constant as a function of lattice spacing are given. The critical mass, critical radius, and multiplication constants for infinite media are tabulated. The design of the neutron source is given, and the reactor physics experiments for which the assembly will be used are outlined. (C.E.S.)

38654 CRITICAL EXPERIMENT IN THE VVR-S REACTOR "EVA" WITH A GRAPHITE REFLECTOR. M. Chernevski and P. Shul'ts (Inst. of Nuclear Studies, Warsaw). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 431-8(1961). (In Russian)

A critical experiment was carried out in the active zone of the VVR-S reactor during a scheduled reactor shutdown on a design assembly containing 10% ^{235}U fuel rods. Graphite blocks 66 × 66 × 600 mm encased in 1 mm thick aluminum were used in the reflector. A total of 30 graphite sub-units were loaded around the periphery, and criticality was carefully approached by loading fuel rods gradually into the center of the core. The reactor EVA contains 3 independent boron safety rods, 4 boron manually-controlled regulating rods connected in two groups RR1 and RR2, an automatic steel control rod, and an Al–Co rod for fine control. The total compensating ability of the fine control rod from 20 to 40 cm was 0.244% $\Delta k/k$. The total worth of the RR1 group was 2.7% $\Delta k/k$, and that of the RR2 group

was 2.8% Δk/k. The "worth" of the automatic control rod was 0.94%. The reactivity introduced by insertion of the fuel rod or graphite was measured from the position of the boron control rods. The distribution of neutron flux in the reactor core was determined by the activation of gold foil having a thickness of 0.2 g/cm^2. (TTT)

38655 THE EFFECTS OF REFLECTORS AT THE VVR-S REACTOR. T. Rosescu and M. Sabau. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 481-6(1961).

Reactor physics studies involving reflector changes in the VVR-S reactor are described. Critical dimensions were modified by changing the nature and dimensions of the reflectors, kinetic properties were varied by changing the mean neutron lifetime, neutron flux increases were brought about, and perturbation effects were increased. The calculation method is given and two-group diffusion theory results are given. (T.R.H.)

38656 DEGREE OF PURITY STUDY ON GRAPHITE WITH THE PILE OSCILLATOR METHOD. P. Liewers and G. Huettel (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 519-25(1961). (In German)

Graphite purity was investigated using a pile oscillator method in which the graphite is compared with a graphite of known purity. For the same form, weight, conditions, and scattering cross sections of different samples, the different reactivity effects depend on the absorption cross section. The experimental arrangement and procedure are described. (T.R.H.)

38657 THE DETERMINATION OF THE VARIATIONS OF REACTIVITY AT THE VVR-S REACTOR. T. Rosescu and M. Sabau. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 541-52(1961).

A study was made of the effect upon reactivity of the variation of different parameters of the VVR-S reactor. The cases of sensitivity maximization for the perturbation measurements due to introduction of absorber, fissionable, or scattering materials into the reactor core with and without moderator channel are considered. (T.R.H.)

38658 SOME PROBLEMS OF THE USE OF PILE OSCILLATOR METHOD IN THE VVR-S REACTOR. Al. Stefanescu and M. Sabau. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 553-66(1961).

A method is described for pile oscillator measurements in the VVR-S reactor to minimize the effect of the resonance integral. An oscillating channel was designed, placed in the core, and surrounded by an internal reflector of natural water. Optimum conditions for pile oscillator measurement of thermal neutron capture cross sections are: period 5 to 30 sec., amplitude 150 mm, with the oscillation center 150 mm from the core center. An electronic system for harmonic analysis of the signal decreases statistical errors. (T.R.H.)

38659 THE AVERAGE LIFETIME OF PROMPT NEUTRONS IN THE VVR-S REACTOR. I. Purica (Inst. of Atomic Physics, Bucharest). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 567-72(1961). (In Russian)

The average lifetime of the prompt neutrons was determined by taking the transmission function of the reactor at frequencies of 20 to 200 cycles per second. If the rotational frequency is large compared to the lifetimes of the delayed neutrons, the transmission function assumes the form: $R(j\omega) = \delta\bar{\phi}/\bar{\rho}\phi_0 = 1/l^*(\alpha + j\omega)$. Here $\alpha = \beta/l^*$, and β is the fraction of delayed neutrons. Oscillations of an absorber in the reactor core, which caused a sinusoidal change in reactivity with frequency ω, were used in taking the transmission function. The average neutron flux ϕ_0 is proportional to the reactor power. A maximum perturbation of 10^{-2}% in reactivity was achieved by rotating a cadmium collar which shielded an ionization chamber. The rotor was actuated by compressed air. The change in the amplitude of the oscillations as a function of reactor power was found to be linear. The transmission function for a reactor not poisoned by xenon was about the same as for a reactor poisoned by xenon. The average lifetime of prompt neutrons for the unpoisoned reactor was $l = 5.6 \times 10^{-5}$ sec. The value of α was found to be 130 ± 10 sec^{-1}. The fraction of delayed neutrons was $\beta = 0.00755$. (TTT)

38660 A RECORDER OF REACTOR POWER HAVING A MOVABLE IONIZATION CHAMBER. A. G. Mandzhavidze. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 573-5(1961). (In Russian)

The power of the IRT-2000 reactor was determined by directly measuring with a potentiometer the current of an ionization chamber in the reactor core. With full deflection of one scale, the instrument was automatically switched to the next higher scale. The minimum power to be measured was 0.1 watt, and the maximum was 100 kw. A microampere meter was used to measure the power above 100 kw. The current from the ionization chamber is fed to a recorder, which indicates whether the signal is "up" or "down," by a relay scheme controlled by a servodrive. The ionization chamber is moved into or out of the reactor core, and thus, continuous control is exercised except for the time necessary to move the ionization chamber. (TTT)

38661 A STUDY OF THE NONLINEAR DYNAMICS OF THE VVR-S REACTOR ON AN ANALOGUE COMPUTER. I. Iftode, K. Tsapu, and K. Dobrescu (Inst. of Atomic Physics, Bucharest). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 577-90(1961). (In Russian)

The shape and peaking of transitory processes in a reactor were determined on an analog computer under varying initial conditions of power and inlet temperature of the secondary cooling water, with varying conditions of cooling the primary and secondary loops, and under conditions of varying the heat transfer coefficients in the heat exchangers. Differential equations are written for the change in power, heat capacity, fuel and water temperature, and precursors which give delayed neutrons as functions of time. The reactor power as a function of time was investigated for an initial power ρ_0 = 500, 1000 and 2000 kw at temperature differences ΔT = 10, 20 and 30°C for reactivity jumps which limit the fuel surface temperature to the boiling point of water, and those which cause a divergent power increase. The power surges in the reactor are plotted as a function of time for various initial conditions and for different mass velocities of coolant in the primary and secondary heat exchangers. (TTT)

38662 DETERMINING THE MULTIPLICATION COEFFICIENT ηf FROM THE CHARACTERISTICS OF XENON POISONING. I. Udrya, K. Kharaga, and L. Mentsesku (Inst. of Atomic Physics, Bucharest). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 591-602(1961). (In Russian)

The average value of ηf (η is the number of fast neutrons for each thermal neutron absorbed by the fuel, and f is the thermal neutron utilization factor) can be determined from the change in reactivity due to xenon poisoning with progressive fuel burn-up. The xenon reactivity is given by the following equation: $\rho_{X_e}(t) = -\eta f \cdot a[1 + b \exp(-ct) - d \exp(-\lambda_1 t)]$. In determining the value of ηf from the xenon poisoning at a given fuel burn-up, it is necessary to know

the ^{239}Pu concentration and the average neutron flux on which the constants a, b, c and d depend. The effect of ^{239}Pu can be neglected, since only a small amount of ^{239}Pu is used (0.078). Hence, the average ^{235}U concentration and average flux can be determined readily by taking into account the burn-up of ^{235}U. This method can be used to determine the value of ηf at high fuel burn-ups, since the calculated changes in reactivity agree well with the experimental value, and in addition, the values of ηf obtained by the xenon method agree well with values obtained by observing the loss in reactivity worth. (TTT)

38663 EXPERIMENTAL EQUIPMENT AND ACCESSORIES USED IN CARRYING OUT RADIOBIOLOGICAL WORK IN THE IRT REACTOR. B. A. Levin (Kurchatov Inst. of Atomic Energy, Moscow). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 603-13(1961). (In Russian)

For a number of radiobiological studies with fast neutrons, a 20% contribution due to γ-radiation is permissible. Pb or Bi shielding is generally employed to separate the fast neutrons from γ-radiation. A horizontal channel 100 mm in diameter in the IRT pool-type reactor was equipped with a boron-bismuth filter (24 mm B_4C + 100 mm Bi) to separate the fast neutrons from the γ-radiation and thermal neutrons. The ratio D_N/D_γ (D_N = dose due to fast neutrons, and D_γ = dose due to γ radiation) varied from 2.5 at 24 cm from the core to 10.9 at 184 cm from the core. The value of D_N varied from 5350 rads/hr to 600 rads/hr at these two positions. The loading and positioning arrangement is described. A container with lead walls 120 mm thick protected on all sides with a 10 mm layer of B_4C was designed for direct irradiation in the reactor core. At a reactor power of 1000 kw, the value of D_γ was <23 rad/sec, while D_N was within the limits of 140 to 190 rad/sec. A simple method of loading and unloading the samples by remote control has been worked out. (TTT)

38664 STUDY ON THE USE OF SHUTDOWN REACTORS AS STRONG γ-RAY SOURCES. W. Suckow (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 615-22(1961). (In German)

In using a shutdown reactor as irradiator for prolonged doses above 10^4 rad, some means of determining absorbed dose must be found. Gamma field measurements conducted for this purpose in the Rossendorf Research Reactor are described. A Philips dosimeter, type 37470, with thimble chambers was used. Measurements of the gamma field as a function of location and of time were carried out. For determination of absorbed dose, radiosensitive glass dosimeters were used. (T.R.H.)

38665 PILE OSCILLATOR MEASUREMENTS OF NEUTRON ABSORPTION CROSS-SECTIONS. J. Bouzyk, W. Suwalski, and J. Topa. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 623-5(1961).

In the second stage of pile oscillator measurements on the EWA (VVR-S type) reactor, neutron absorption cross section measurements using the global signal method were conducted. The sample was oscillated with a period of 40 seconds and an amplitude of 50 cm in the air channel. Measurements with a gamma-compensated ionization chamber were taken. Results are given and evaluated for Li, S, K, V, Fe, Cu, Zn, Se, Ag, In, and Au. (T.R.H.)

38666 WATER TREATMENT OF THE VVR-M REACTOR AT THE A. F. IOFFE INSTITUTE OF TECHNICAL PHYSICS, ACADEMY OF SCIENCES, USSR. V. D. Ganzha, K. A. Konoplev, R. N. Rodionova, Yu. P. Saikov, V. D. Trenin, and V. T. Sharov. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 629-33(1961). (In Russian)

The quality of the water in the primary cooling circuit is low during the initial period of reactor operation due to the accumulation of corrosion products and other impurities. The stainless steel piping was degreased with gasoline, and then etched with a solution containing 4.5% H_2SO_4, 5% HNO_3 and 2% HCl for a period of 2-3 hours at a temperature of 80 to 90°C. The pipe was then passivated with 30% HNO_3 at a temperature of 20°C for a period of 2 days. This treatment prevented corrosion in the primary cooling circuit, as was evident from a direct inspection of the piping after a period of reactor operation. An ion-exchange column containing a cation resin KU-2 (similar to Dowex-50) and an anion resin EDE-10P in two layers was installed, and the purity of the resulting water was controlled by its specific resistance. After 22 hours operation, the residual solids content of the water was decreased from 5.8 to 1.0 mg/l, and the specific resistance increased from 5×10^4 to 3.7×10^6 ohm-cm. The activity content of the water was decreased by an order of magnitude from 7×10^4 to 8×10^3 counts/min. The oxygen content of the water increased from 6.4 mg/l at zero power to 15.5 mg/l at a power of 10 Mwatts. Special corrosion tests on metallic samples of beryllium indicated that beryllium metal was not undergoing any significant corrosion in the water. (TTT)

38667 UNIT FOR THE CLOSED-CYCLE DEGASIFICATION AND REMOVAL OF SALT FROM THE PRIMARY COOLING WATER BY THERMAL MEANS IN THE VVR-M REACTOR. V. S. Karasev (Inst. of Physics, Kiev). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 635-40 (1961). (In Russian)

In order to decrease the radioactive contamination due to release of radioactive gases, and in order to remove ionic and colloidal radioactive impurities, an electrically heated evaporator was included in the primary cooling circuit. Non-condensable gases were sucked out of the evaporator by a jet, and passed over a recombiner containing a palladium-impregnated catalyst (10 liter of Pd catalyst) in order to recombine O_2 and H_2 to give H_2O. The vapor is condensed, and the condensed liquid is fed by a pump back to the evaporator. The electric heater in the evaporator has a power of 30 kw, and can produce 45 kg of saturated steam per hour at a pressure of 1.9 kg/cm^2. The jet (throat diameter of 6.2 mm) can circulate 50 cm^3 of air per hour through the system. The residual solids content of the water was decreased by a factor of 5 after operating the evaporator for 40 days. The activity of the discharge air was considerably reduced by the closed-cycle recirculation of the radioactive gases. (TTT)

38668 OPERATING EXPERIENCE WITH THE HEAVY-WATER REACTOR OF THE ACADEMY OF SCIENCES OF THE USSR. S. A. Gavrilov. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 641-8(1961). (In Russian)

The heavy-water reactor of the USSR Academy of Sciences, which had operated since 1949, was renovated in 1957 with an increase in power from 500 kw to 2500 kw, and with an increase in neutron flux from 2.5×10^{12} to $\sim 3.0 \times 10^{13}$ neutrons/cm^2 · sec. The number of experimental irradiation channels was significantly increased. The reactor system contains 4500 liters of heavy water, 270 kg of uranium (2% enriched) and 3 m^3 of helium. Heavy water serves as the moderator, reflector and heat transfer medium. There were 9 neutron channels and a thermal column. Three of the channels had a neutron beam of 2×10^9, and six of the channels had neutron fluxes of 0.82 to 6×10^9 neutrons/cm^2 · sec. At a power of 2500 kw, one fuel loading lasted 10,000 hours or two years for a 5-day week operation. The ^{235}U burn-up was 22%. The temperature in each channel was monitored, and the activity in the circulating helium

was continuously checked in order to detect fuel ruptures as soon as possible. Gas samples from each channel could also be monitored for activity in locating breaks in the fuel slugs. The reactor was shut down for one to two hours daily in order to load and unload materials for irradiation, but materials could also be loaded and unloaded by remote control while the reactor was in operation, if necessary. The heavy water system was completely sealed, and the average loss was 25 liters of heavy water per year. The helium was 20 to 30 m^3 per year. Reactivity changes caused by burn-up of ^{235}U could be compensated by varying the liquid level of heavy water in the reactor. Since the reactor was operated only 5 days per week, it was convenient to schedule reactor maintenance over the week-end. The radiation exposure was controlled to limit the dose received by any of the maintenance personnel. (TTT)

38669 OPERATING EXPERIENCE AND TECHNICAL DEVELOPMENT OF THE ROSSENDORF RESEARCH REACTOR. E. Adam (Zentralinstitut fur Kernphysik, Rossendorf, Ger.). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 657-66(1961). (In German)

Changes made in the Rossendorf Research Reactor since the reactor conference in June 1960 are reported. A tabulation of reactor operations is given. Other sections deal with control changes, burnup studies, instrumentation improvements, and the question of isotope production. (T.R.H.)

38670 OPERATING EXPERIENCE OBTAINED WITH THE HUNGARIAN VVR-S REACTOR. G. Verle, L. Varkonyi, and I. Toth (Central Research Inst. of Physics, Budapest). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 667-80(1961). (In Russian)

From July 1st, 1960 to June 30th 1961, the reactor operated 2394 hours and completed 4592 megawatt hours of operation without incident. Inspection of the primary cooling circuit, valves and pumps during a general overhaul of the reactor in 1961 showed only slight signs of corrosion. Various hand operations were mechanized. An ion exchange column using cation and anion resins was installed to decontaminate the water of the primary cooling circuit. The design of various tools used for remote control work is described. The positioning of objects in the irradiation channels is given. The remote control handling of radioactive materials is carried out safely with the use of manipulators. Gamma counters hooked up to warning lights and bells were used to detect stray activity. Air monitors sampled the air at a rate of 100 m^3/hr, and the collected beta emitters were measured with a scintillation probe 5 cm in diameter. Individual dosimeters and film badges were worn by the operating personnel. A fission chamber was used to detect an increased neutron level up to criticality. This unit was used in reactor start-up. The safety of the control rods was improved. (TTT)

38671 THE RESULTS OF OPERATING THE VVR-S-IAF REACTOR IN BUCHAREST. I. Purica, I. Udrea, D. Stoian, K. Chiotan, and R. Vidrigin (Inst. of Atomic Physics, Bucharest). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 681-9(1961). (In Russian)

The average reactor power was 1800 kw with an average operating time of 200 hours per month (5 days per week with two 6 hour shifts per day). A reactivity reserve greater than 2×10^{-2} was required for continuous operation. The change in reactivity with fuel burn-up is given for a xenon-poisoned reactor. The pH, residual solids, and content of organic matter of the primary cooling water varied within the allowable limits. The most important isotopes produced in the reactor were ^{32}P, ^{45}Ca, ^{35}S, ^{65}Zn, ^{192}Ir, ^{60}Co, ^{198}Au, ^{204}Tl and ^{131}I. In addition, materials were also irradiated for research purposes. The annual shutdown period in August lasted for 21 days. The irradiation channels were modified so that 3 samples could be simultaneously irradiated instead of only one sample. (TTT)

38672 EQUALIZING THE TEMPERATURES ON THE SURFACE OF FUEL ELEMENTS IN THE CORE OF THE VVR-S REACTOR OF BUCHAREST. D. Stoian and I. Mihaila. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 691-701(1961). (In Russian)

The temperatures in a reactor core depend on the distribution of the thermal neutron flux and on the flow pattern of the cooling water through the core. Choke collars were distributed in three separate zones in order to adjust the flow of cooling water so as to even out the surface temperatures of the fuel rods. The pressure drop was calculated from the formula: $\Delta P = \zeta(\gamma/2g)\overline{W}^2$. Here ζ is the hydraulic resistance coefficient; γ is the specific weight (kg/m^3) and $\overline{W}$ is the average water velocity (m/sec). With an inlet water temperature of 34°C, the highest surface temperature did not exceed 81.6°C, which is below the boiling point of water. The reactor power can be safely increased from 2000 to 3300 kw on increasing the mass flow rate of the cooling water from 660 to 1000 m^3/hr and allowing the surface fuel temperature to rise to 92°C. The temperature in positions near the control rods is about 10°C lower, while the temperature at positions far from the control rods is 1 to 3°C high. (TTT)

38673 THE RESULTS OF MEASURING THE INTENSITY OF CHERENKOV RADIATIONS IN THE IRT-2000 REACTOR BY MEANS OF THE FEU-19M PHOTOMULTIPLIER. G. S. Karumidze (Inst. of Physics, Tbilis, USSR). Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 703-8(1961). (In Russian)

Any charged particle moving in a transparent medium can emit visible light, if its velocity exceeds the phase velocity of light. The condition for the occurrence of Cherenkov radiation is that $\beta n > 1$, where $\beta = \nu/e$. Here ν is the velocity of the charged particle; n is the refractive index of the medium, and e is the velocity of light. The γ rays from a reactor can lead to Cherenkov radiation. The total Cherenkov radiation from γ rays can be subdivided into the Cherenkov radiation from prompt γ rays and the delayed Cherenkov radiation from the build-up of fission products: $S = S_1 + S_2$. The Cherenkov radiation in a reactor was measured with a photomultiplier tube while bringing the reactor up to a power of 1000 kw with a power doubling period of 20 seconds. The photomultiplier current or growth of Cherenkov radiation is directly proportional to the reactor power. The reactor power from 10 to 1000 kw can be estimated from the photomultiplier current. (TTT)

38674 OPERATING EXPERIENCE WITH THE HEAVY-WATER RESEARCH REACTOR OF THE ACADEMY OF SCIENCES OF CHINA. Vei-tszin Chen. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 709-20(1961). (In Russian)

Heavy water is used in the reactor as a moderator and heat transfer medium. The nominal reactor power is 7000 kw with a maximum power of 10,000 kw. The maximum fuel loading is 340 kg of 2% enriched uranium fuel. The reactor has 6 horizontal channels, one thermal column, and 43 vertical channels, of which 9 are in the core and 34 in the reflector. Helium is used in removing and burning the oxygen-hydrogen mixture formed during irradiation. A distillation unit was used only rarely because the purity of the heavy water was satisfactory. Ordinary water was used in the secondary circuit to cool the heavy water, and no cross-

contamination could be detected. Corrosion was observed in the vertical experimental tubes of the reactor core. Heavy water leaked through the hole into the dry tube. The background radiation in the helium loop rose to 8.3 μr/sec as a result of argon activation. As a result of a (n,p) reaction on ^{16}O to form ^{16}N, the radiation reading in the heavy water circuit rose to 1050 μr/sec. The reading falls off to 250 μr/sec in a half hour after reactor shutdown. The vertical neutron flux distribution in the reactor is dependent on the position of the control rods. At a reactor power of 2090 kw, the neutron flux in a central channel was $2.44 \pm 0.22 \times 10^{13}$ neutrons/cm^2 · sec. The reactivity worth was usually determined on Monday at low reactor power. The xenon poisoning was measured at a reactor power of 2000 kw. (TTT)

38675 MEASURING THE POWER OF THE IRT-2000 REACTOR FROM THE GAMMA ACTIVITY INDUCED IN THE HEAT-TRANSFER MEDIUM. N. M. Katamadze. Rev. Phys., Acad. Rep. Populaire Roumaine, 6: Suppl., 721-4(1961). (In Russian)

Reactor power is proportional to the neutron flux, and can be measured from the activities ^{16}N and ^{19}O which are induced in water and formed by the following reactions: $^{16}O(n,p)^{16}N$ and $^{18}O(n,\gamma)^{19}O$. The half-life of ^{16}N is 7.65 sec, and the energies of its γ quanta are 6.2 and 7.1 Mev. The activity of ^{19}O is 29.4 sec with a γ-ray energy of 1.6 Mev. The ^{19}O activity and impurity activities in the water are small compared to the ^{16}N activity. At a reactor power of 10 to 200 kw, the γ activity was measured with a NaI(Tl) scintillation counter, and with an ionization chamber at higher reactor powers. The results showed that at mass water flow rates of 100 and 180 m^3/hr, the γ-ray reading is directly proportional to the reactor power. After calibration the γ-ray readings gave correct values of the reactor power as calculated by a thermal balance, even when the position of the control rods was varied. A 9% error was observed on attempting to determine the reactor power from the readings of a neutron ionization chamber when the position of the control rods was varied. Thus, the γ-ray method of determining reactor power does not depend on the neutron distribution in the reactor core. In addition, it is not necessary to place a counter in a high neutron and γ-ray field. (TTT)

38676 PROBLEME BEIM ENTWURF VON FORSCHUNGSREAKTOR-INSTITUTEN. Problems in the Design of Research Reactor Institutes). Friedrich Wilhelm Krahe. Thesis, Berlin, Technische Universität, 1963. 194p.

A representative cross section is presented of problems in the design of research reactor institutes. In order to facilitate gross comparisons, all plans for construction were drawn on the same scale. The construction aspects considered were measurement devices, radiation sources, reactors, use of radioisotopes, effect of radiation, shielding, selection of reactor sites, scope and form of research institutes, reactor halls, control rooms, auxiliary rooms, hot cells, laboratories, lecture rooms, and libraries. 108 references. (J.S.R.)

38677 HIGH FLUX BEAM REACTOR. J. Chernick, K. W. Downes, J. M. Hastings, J. M. Hendrie, and H. J. C. Kouts (to U. S. Atomic Energy Commission). U. S. Patent 3,143,478. Aug. 4, 1964.

A nuclear fission reactor is designed which is capable of producing high intensity, external beams of neutrons. The reactor comprises a heavy water moderated core which is undermoderated within the core and has external control rods, causing the peak thermal neutron flux to be external of the core and the peak fast neutron flux to be separated from the former and located within the core. This effective separation of neutron fluxes makes it possible to withdraw neutron beams of uniform thermal energies. The actual withdrawal is accomplished by tangential beam tubes extending from the perimeter of the core region. (AEC)

38678 SELF-CONTAINED LOOP FOR STUDYING MATERIALS UNDER IRRADIATION IN A SWIMMING POOL REACTOR. Roger Chabassier, Gerard Dupuy, Bernard Lerouge, and Jean Megret. U. S. Patent 3,144,392. Aug. 11, 1964. Priority date May 20, 1960, France.

The self-contained loop comprises a cooling circuit incorporating a test duct, a structure supporting the circuit, a supporting assembly, and means for displacing the structure relative to the assembly in order to place the test duct in position against the core. (D.L.C.)

WASTE DISPOSAL AND PROCESSING

Refer also to abstract 37443.

38679 (A/CONF.28/P/86) IMPROVEMENTS IN THE TREATMENT OF RADIOACTIVE RESIDUES. Gérald Wormser, Jean Rodier, and Emmanuel de Robien (France. Commissariat à l'Énergie Atomique, Paris). May 1964. 15p.

Processes and facilities for the treatment of low- and medium-activity effluents from radioactive sources in France are discussed. (R.E.U.)

38680 (A/CONF.28/P/88) NEW INDUSTRIAL FACILITIES OF THE COMMISSARIAT A L'ENERGIE ATOMIQUE FOR THE PROCESSING OF LIQUID AND SOLID RADIOACTIVE WASTES. Pierre Cerre, Emile Mestre, and Jean Bourdez (France. Commissariat à l'Energie Atomique, Paris). May 1964. 16p.

Descriptions are given of the principle, operation, and performance of facilities used in France for processing low- and medium-activity liquids and solids. (D.L.C.)

38681 (A/CONF.28/P/187) TECHNIQUES AND ECONOMICS OF RADIOACTIVE WASTE TREATMENT. T. G. Hughes (United Kingdom Atomic Energy Authority. Production Group, Windscale, Sellafield, England, D. W. Clelland, and B. F. Warner. May 1964. 15p.

A description is given of the systems used at Windscale for the treatment of radioactive liquid wastes arising from the two fuel reprocessing plants. High-, medium-, and low-activity wastes are considered. The effectiveness of the systems are discussed, and the improvements that have been made are described. (D.L.C.)

38682 (A/CONF.28/P/188) WORK IN THE UNITED KINGDOM ON FIXATION OF HIGHLY RADIOACTIVE WASTES IN GLASS. K. D. B. Johnson, J. R. Grover, and W. H. Hardwick (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). May 1964. 15p.

Experimental and theoretical work was carried out on the fixation in glass of the wastes from power reactors using U metal fuel of near-natural isotopic composition. The operating experience of the FINGAL pilot plant is described, and its scale-up is discussed. The storage conditions are considered. It is concluded that the costs of fixation and storage of wastes are small compared with the electric power produced. (D.L.C.)

38683 (A/CONF.28/P/587) THE THERMIC METHOD OF VITRIFICATION OF THE RADIOACTIVE PULPS AND THE SAFE DISPOSAL PROBLEM OF VITREOUS PREPARATIONS. N. I. Bogdanov, V. G. Vereskunov, F. S. Dukhovich, P. V. Zimakov, B. S. Kolychev, V. S. Kuzucheva, V. V. Kulichenko, V. P. Martynov, and E. T. Rastorguev (U.S.S.R.). May 1964. 20p.

A continuous thermal treatment process for converting radioactive pulps containing metal hydroxide mixture into vitreous preparations is discussed, together with the conditions for safe disposal of these preparations. The process physico-chemical principles and bases for using a fluidized bed of quartz sand for dehydration of the pulps and calcination of their solid residue are outlined. The principal plant flow diagram is presented, and the main results of its testing in a pilot plant are given. A study of the radiation stability of vitreous preparations showed that surface destruction occurred during the irradiation, leading to increased solubility of the preparations and to the formation of the mechanically undurable and radiation instable products on the surface. It was found that the destruction of the surface was caused by the radiation chemical reactions of the components of fused preparations with the air components. The process rate decreases with increasing temperature as the gas adsorption on the surface of the preparations decreases and the annealing of radiation defects occurs. Simpler storage constructions for the highly active vitreous preparations as compared to the storages for the liquid and the other types of solid wastes are proposed on the basis of complex investigations of properties of vitreous preparations. On optimum temperature for ground disposal of about 700°K during the first period of storage is recommended on the basis of experiments with real vitreous preparations and electrical modelling with simulated preparations, as well as on the basis of thermophysical calculations. The storage dimensions and arrangements are defined. (auth)

38684 (A/CONF.28/P/609) PROCESSES FOR THE RECOVERY AND PURIFICATION OF FISSION PRODUCTS FROM IRRADIATED URANIUM. Sten Ahrland and Karl Erik Holmberg (Aktiebolaget Atomenergi, Studsvik, Sweden) May 1964. 14p.

Among the various methods for processing waste solutions, ion exchange using inorganic compounds, and freezing out, are studied. Zirconium phosphate and the hydrous oxides of zirconium and silicium (silica gel) have been judged as the inorganic ion exchangers of greatest promise. Zirconium phosphate is moderately acidic, the hydrous oxides only weakly. In fact the zirconium hydrous oxide is amphoteric, acting mainly as an anion exchanger when pH < 5. The selectivity between ions of different charges generally increases with decreasing acidity. On the other hand, a certain degree of sorption is reached at a lower pH value, the more acidic the gel which may be important for easily hydrolyzed ions. For pH > 8, zirconium phosphate is heavily hydrolyzed and is thus not useful as an ion exchanger. Silica gel can be used up to a pH = 9, where dissolution becomes appreciable. The workable ranges of pH, as well as other properties of the investigated ion exchangers, thus supplement each other rather well. On partial freezing of a concentrated solution of uranyl nitrate containing a small amount of fission products, uranyl nitrate and ice crystallize leaving the fission products in the mother liquid. The phases may be separated by centrifugation, leaving the solid somewhat contaminated by mother liquid. By repeated partial freezing it should be possible to purify the uranyl nitrate further. The more important fission products have been tested and do not appear to co-crystallize with uranyl nitrate. The freezing out of uranyl nitrate and ice may also be performed in the presence of moderate concentrations of nitric acid, which reduces the solubility of the uranyl nitrate. It thus seems physically possible to recover a considerable fraction of uranium in a rather pure form from a concentrated uranyl nitrate solution containing small amounts of fission products by repeated fractional freezing. Simultaneously the high activity waste is concentrated in a reduced liquid volume. (auth)

38685 (A/CONF.28/P/774) ASPHALT CONDITIONING AND UNDERGROUND STORAGE OF CONCENTRATES OF

MEDIUM ACTIVITY. P. Dejonghe, L. Baetsle, N. Van de Voorde, W. Maes, P. Staner, J. Pyck, and J. Souffriau (Centre d'Etude l'Energie Nucleaire, Brussels). May 1964. 16p.

Two studies were carried out on the problem of storage of medium-activity wastes. Insolubilization of Wastes. It was found that concentrates can be insolubilized by violent stirring into hot asphalt at 200°C. Elution tests and pilot plant tests were made. An industrial plant for processing of sludges is described. Migration of Radioelements in Ground. Tracer studies were made of migration in sandy soils and ground-water table. (D.L.C.)

38686 (A/CONF.28/P/775) A REVIEW OF RESEARCH WORK ON RADIOACTIVE WASTE TREATMENT CARRIED OUT IN THE NUCLEAR RESEARCH INSTITUTE OF THE CZECHOSLOVAK ACADEMY OF SCIENCES. L. Berak, Z. Dloughy, F. Kepak, J. Napravnik, J. Ralkova, J. Saidl, L. Schejbalova, V. Vesely, and J. Zaruba (Ceskoslovenska Akademie Ved. Ustav Jaderneho Vyzhumu, Rez). May 1964. 10p.

Developments in decontamination and disposal of wastes are described, including facilities and processes for decontaminating effluents, sorbents for radioactive particles, fixation and solidification of concentrates, and a scintillation counter for weakly active waters. (D.C.W.)

38687 (A/CONF.28/P/783) SUBTERRANEAN DISPOSAL OF RADIOACTIVE WASTE IN CAVITIES MADE IN SALT FORMATIONS. G. Richter-Bernburg (Germany. Bundesanstalt fur Bondenforschung, Hanover). May 1964. 16p.

Only one kind of rock is truly impermeable to ground water: halite or rock salt. Some of the physical and geological properties of halite are described, and it is shown that domes or diapirs are better for waste storage than table formations. The creation of cavities in salt deposits for waste storage is considered, and some salt formations in Europe suitable for such applications are discussed. (D.L.C.)

38688 (A/CONF.28/P/784) RETENTION OF FISSION PRODUCTS BY PEAT HUMIC ACIDS, A NEW POSSIBILITY IN WASTE WATER TREATMENT. A. Szalay and M. Szilágyi (Magyar Tudományos Akadémia Atommag Kutató Intézete, Debrecen). May 1964. 11p.

The authors investigated the retention of fission products on peat preparations in laboratory tracer experiments. The experiments demonstrated that the majority of the fission products, the cations, are strongly fixed on peat humic acids if approximately favorable conditions are secured. The fission products can be classified according to thier fixation on humic acids into anionic and cationic groups. For an efficient binding, the pH of the aqueous phase must be kept between limits of about 4 to 6, optimally at about 5. The elution sequence of the long-living cationic fission products was investigated, and the "breakthrough volume" was determined under optimal laboratory conditions from chemically pure tracer solutions. The sorption capacity of one ton of peat is roughly about one thousand chemical equivalents. This is sufficient for the fixation of megacuries of Sr and Cs. The breakthrough volume—the tolerable amount of waste water—filtrable by a given quantity of peat is about 1000 to 10,000 times its quantity, if optimum conditions are secured. Further investigations concerned the possible interference of various non-radioactive chemical contaminants which might be present in industrial waste waters. The presence of salts, complexing agents and detergents can cause displacement or even remobilization of the sorbed fission products. The breakthrough volume is decreased if their concentration is excessive. The volume and weight of the contaminated peat humic acids can be reduced to a very small fraction by incineration before ultimate disposal. (auth)

38689 (A/CONF.28/P/794) MANAGEMENT OF RADIOACTIVE WASTE AT TROMBAY (A SURVEY REPORT). R. V. Amalraj, A. R. Chinoy, J. D. Sehgal, and K. T. Thomas (India. Atomic Energy Establishment, Trombay). May 1964. 19p.

The Atomic Energy Establishment Trombay houses both industrial and research set-ups, including such diverse facilities as production units for uranium, thorium, and plutonium; fuel element fabrication shop; laboratories; and research reactors. The radioactive wastes produced vary widely over a spectrum of activity levels and chemical nature. The magnitude of the problem is presented, and the manner in which it has been solved or is proposed to be solved is dealt with. Strict limits are put on the discharge of radioactivity at Trombay, owing to the low water renewal rate of Bombay Harbor Bay, the existence of fishing and salt production industries dependent on the bay waters, the nearness of the center to the city of Bombay, and the high water table and heavy monsoon rains in the area. Various factors were considered for evolving a suitable waste management philosophy at Trombay. Details of these considerations and short descriptions of existing and proposed waste treatment plants and facilities including methods of handling radioactive sludges and management of high level wastes from the fuel reprocessing plant are given. Research work being carried out for improvement of present techniques and development of new methods of treatment and disposal is summarized. (auth)

38690 (AEET/HP/RWD/4) NATURE OF WASTES. Working Party No. 2. A. R. Chinoy and A. K. Ganguly (India. Atomic Energy Establishment, Trombay). Feb. 5, 1959. 18p.

Various sources of wastes in the nuclear industry are analyzed for radioactivity and other characteristics. Hazards from radiation and chemicals in the wastes are discussed. (31 references). (C.H.)

38691 ACTION GUIDES FOR RADIOACTIVE EFFLUENTS FROM PRTR. Richard F. Foster (General Electric Co., Richland, Wash.), George E. Backman, Norman G. Wittenbrock, and John M. Skarpelos. J. Sanit. Eng. Div., 89: No. SA6, 17-35(Dec. 1963).

The Plutonium Recycle Test Reactor (PRTR) and the existing guides for the control of radioactive effluents and for emergency operations are discussed. (C.H.)

38692 REMOVAL OF LIQUID RADIOACTIVE WASTES FROM THE LABORATORY. E. Gashpar, and P. Shandru (Inst. for Atomic Physics, Bucharest). Symp. Tech. Zagadnien Ochrony Promieniowaniem, Warsaw, 435-45(1962). (In Russian)

The radioactive wastes from a laboratory can be conducted in a diluted state in the public sewers under the assumption that their specific concentration and their general daily activity will not exceed a given value. If these values are exceeded, the wastes must be stored in special vats until the activity has reached a permissible value. When $T_{\frac{1}{2}} > 15$ days, the radioactive wastes are filtered through a series of filters before they are released to the public sewers. (tr-auth)

38693 METHODS OF REMOVAL OF RADIOACTIVE WASTE FROM ISOTOPE LABORATORIES IN POLAND. A. Wasilewski and Z. Ksiazak (Central Laboratory for Radiological Protection, Warsaw). Symp. Tech. Zagadnien

Ochrony Promieniowaniem, Warsaw, 446-55(1962). (In Polish)

The present situation in Poland with respect to the disposal of radioactive wastes is reported from the viewpoint of radiation monitoring of isotope laboratories. The possibilities for the decontamination of some liquid and solid wastes in some areas are discussed. (tr-auth)

38694 DECONTAMINATION OF RADIOACTIVELY POLLUTED LABORATORY WASTES. H. Koch (Institut für Angewandte Radioaktivitat, Leipzig). Symp. Tech. Zagadnien Ochrony Promieniowaniem, Warsaw, 456-67 (1962). (In German)

The decontamination of radioactive wastes is still in such a state of flux that the selection of the different decontamination methods depends on the given situation. Results obtained from coprecipitation reactions of a number of radioisotopes with various precipitation agents are discussed. The laboratory wastes with constantly changing radioisotope composition can be decontaminated by a single precipitation with phosphate or mixed phosphate-ferrocyanide. As research with waste processing installations have shown, in almost all cases a single precipitation will reduce the radioactivity of wastes below the permissible limits. The waste processing installations consist of numerous storage containers with 2.5 m^3 capacity that are connected with precipitation, filtering, and control devices. (tr-auth)

38695 DEVELOPMENT, CONSTRUCTION, AND OPERATION OF THE CENTER FOR RADIOACTIVE WASTE AND SEWAGE AS AN EXAMPLE FOR STUDY OF A SOLUTION TO THE PROBLEM OF RADIOACTIVE WASTE IN A COUNTRY WITH HIGH POPULATION DENSITY. H. Weiss. Symp. Tech. Zagadnien Ochrony Promieniowaniem, Warsaw, 468-75(1962). (In German)

In 1959, the Center for Radioactive Waste and Sewage was established to study the problem of radioactive waste disposal in a country with high population density. The present structure of the Center and the distribution of studies to the various divisions are reported. The organization of the transportation service and the storage of radioactive wastes are described. The Lohmen project and the results obtained from it up to the present are reported. The international connections of the Center are discussed. (tr-auth)

38696 EXPERIENCE IN CONSTRUCTION AND MANAGEMENT OF A RESEARCH INSTALLATION FOR SEPARATION OF RADIOACTIVE WASTES AT THE INSTITUTE FOR APPLIED ISOTOPE RESEARCH, BERLIN-BUCH, DDR. D. Schoenberg (Institut für Angewandte Isotopenforschung, Berlin). Symp. Tech. Zagadnien Ochrony Promieniowaniem, Warsaw, 476-88(1962). (In German)

The constructional and technical aspects of the Institute for Applied Isotope Research are described. The flow scheme is explained. The accumulating quantities of wastes are discussed in connection with the function and dimensions of the installation. The precipitation and measurement methods used in waste processing are described, and the results are reported. The limits of applicability of such coprecipitation methods are discussed. (tr-auth)

38697 STUDY OF THE USE OF MINERAL COAL FOR PURIFYING RADIOACTIVE WASTE WATER. J. Makowski (Inst. for Hydrological Construction, Gdansk, Poland). Symp. Tech. Zagadnien Ochrony Promieniowaniem, Warsaw, 489-99(1962). (In Polish)

The results of research on the application of Polish mineral coal to the purification of waters and radioactive wastes are discussed. The study was carried out by means of filtration of the radioactive water solutions in sorption columns filled with various types of mineral coal and on prepared solutions, sea water, river water, tap water, and municipal sewage. The radioisotopes ^{90}Sr, ^{137}Ba, ^{137}Cs, and ^{144}Ce were considered. The most suitable type of mineral coal, the optimum pH value for the solution, the minimum length of the sorption column, and the decontamination coefficients obtainable with this method were reported. (tr-auth)

38698 TREATMENT INSTALLATION FOR RADIOACTIVE WATERS OF THE C.E.N. AT MOL (BELGIUM). P. Dejonghe. Techn. Sci. Munic., 58: 429-34(Dec. 1963).

Treatment of radioactive waste effluents displaying low, moderate, or high radioactivity is discussed. The treatment installations considered employ double chemical treatment followed by ion exchange; this treatment permits elimination of 99% of the β emitters and even more of the α emitters. The treatment concentrates are filtered after congelation and then dispersed in a hot asphalt bath. Such a mixture contains approximately 45% hard sediment and is virtually insoluble. (Public Health Eng. Abstr., 44: No. 8, Aug. 1964.)

38699 PROBLEMS OF DECONTAMINATION WITH ION EXCHANGERS. Friedrich Martinola. Tribune CEBEDEAU (Centre Belge Etude Doc. Eaux), 16: 459-64(Oct. 1963).

The use of ion exchangers constitutes a very important procedure for the decontamination of radioactively polluted waters. The simplicity of pile design of the installations and the reduced cost of the preparation due to its high efficiency permit economic exploitation in practice. In permanent installations for treatment of radioactive waste waters, it is advisable to regenerate the exchangers and reuse them a number of times. The exchanger should be employed only a single time, however, if it is necessary to obtain potable water. For salt-free waters, such as those used for cooling and moderating the piles, the ion exchanger is the only substance that, technically and economically, gives complete satisfaction in decontamination. (Public Health Eng. Abstr., 44: No. 8, Aug. 1964).

38700 LOW-LEVEL RADIOACTIVE WASTES—THEIR HANDLING, TREATMENT, AND DISPOSAL. Conrad P. Straub (Robert A. Taft Sanitary Engineering Center, Cincinnati). 1964. 444p. $1.50(GPO).

This book describes techniques for the handling, treatment, and disposal of low-level wastes to keep radiation exposure to a practicable minimum. Discharge to water, soil, and air is considered, and the removal of radioactivity by water treatment processes, biological processes, chemical processes, etc., is discussed. Finally, public health implications are considered. (D.L.C.)

GENERAL AND MISCELLANEOUS

38701 (A/CONF.28/P/577) NEEDS OF NUCLEAR POWER GENERATION AND THE RELATED PROGRAMME IN JAPAN. (Japan. Atomic Energy Commission, Tokyo). May 1964. 10p.

The future energy demands and resources of Japan are considered, emphasizing the importance of nuclear power; and the nuclear power development program is discussed. Efforts in power reactor and nuclear ship development are indicated. (D.C.W.)

38702 (A/CONF.28/P/598) PROSPECTS OF INTEGRATING NUCLEAR PLANTS WITHIN THE PORTUGUESE POWER SYSTEM. A. Leite Garcia (Portugal. Companhia Portuguesa de Industrias Nucleares, Lisbon), J. Cruz Morais, and Sidonio Pais. May 1964. 15p.

Technical factors considered in the integration of conventional and nuclear thermal plants into the present Portuguese power system are reviewed. Economic effects of the nuclear power plants are considered. (R.E.U.)

38703 (A/CONF.28/P/604) CURRENT METHODS FOR LONG-TERM PLANNING OF ELECTRICITY SUPPLY IN SWEDEN. N. Holmin (Sweden. Kungliga Vattenfallsstyrelsen, Stockholm), G. Lindstroem, and M. Mårtensson. May 1964. 16p.

With special reference to Swedish conditions, the methods used by the power companies for optimizing their power systems are described. Different methods used for short- and long-term forecasts of power consumption are given. The importance for the long-term planning of parameters such as cost of capital and labor, fuel costs, and other parameters is discussed. The cost functions for different means of power generation, namely hydropower stations including storage, conventional steam power stations and nuclear power stations, and transmission are given; and the methods used for forecasting possible future trends in relative costs are presented. The problem of reserve capacity as a limiting factor with regard to unit size is considered. Based on the forecasts with regard to demand and costs, the most economical composition of the future power generation system is calculated with methods based upon programs used by the power companies to achieve optimum utilization of water storage resources. A detailed presentation is given on methods used for optimizing a system containing generating capacities in the form of conventional steam power and nuclear power with different cost characteristics as a supplement to hydro power. The distinction between a predominantly hydroelectric system and a purely thermal system with regard to the function of thermal power and, especially, nuclear power is discussed. In a hydroelectric system the nuclear power has to be matched not only to the conventional thermal power, but also to the water storage reservoirs and their in-flow statistics. Thereby, it is possible to achieve a high load factor for the nuclear power by means of the storage system itself and an operating scheme based on the evaluation of the incremental water value. Numerical examples are given for Swedish conditions, particularly the economic penalties inflicted, if costs should develop in a different direction from that used in optimizing the system. (auth)

38704 (A/CONF.28/P/741) WORLD ENERGY REQUIREMENTS AND THE ECONOMICS OF NUCLEAR POWER WITH SPECIAL REFERENCE TO UNDERDEVELOPED COUNTRIES. H. J. Bhabha and M. Dayal (India. Atomic Energy Establishment, Trombay). May 1964. 20p.

The growth of energy demands in the world and the resources of conventional and nuclear fuels are analyzed. A regional analysis is then made for the various areas of the world and it is found that the so-called under-developed regions will have an even greater specific need for nuclear energy than other areas due to the relative shortage of conventional fuel as compared with potential demands. The new economic data relating to various types of nuclear and conventional stations is examined. A detailed examination is made of the latest situation in India with regard to conventional and nuclear power, their relative costs in the different areas of the country, and the growth in power and energy demands in the country. Cost information is presented on the Tarapur Atomic Power Station and detailed cost break-down and power costs are furnished for the Rajasthan Atomic Power Station and other stations based on heavy water-type reactors to be built in India. (auth)

38705 (A/CONF.28/P/879) SUR L'ACTIVITÉ SCIENTIFIQUE DANS LE DOMAINE DE L'APPLICATION DE L'ÉNERGIE ATOMIQUE À DES FINS PACIFIQUES EN R.P. DE BULGARIE. (Scientific Activities in the Application of Atomic Energy for Peaceful Uses in Bulgaria). G. Nadjakov (Bulgarian Academy of Sciences. Nuclear Research Center. Inst. of Physics, Sofia). May 1964. 15p.

A summary is given of the research activities in Bulgaria. The uses of the IRT-1000 reactor, neutron physics, fission of heavy nuclei, photonuclear reactions, radioactivity measurements, studies of diffusion in emulsions, cosmic radiation, radiation effects on semiconductors and dielectrics, nuclear and elementary particle physics, the production of radioisotopes, and the uses of radioisotopes in chemistry, medicine, biology, and industry are briefly discussed. (C.E.S.)

38706 (BNL-8252) POSSIBLE ROLES OF MELANIN IN SOME EXTRAPYRAMIDAL FUNCTIONS. Melvin H. Van Woert and George C. Cotzias (Brookhaven National Lab., Upton, N. Y.). July 15, 1964. Contract AT-30-2-GEN-16. 6p.

Preliminary results are reported from studies on the biochemistry of melanin granules isolated centrifugally from the livers of amphibians. The granules were found to contain significant amounts of monoamine oxidase and to concentrate radiomanganese when injected into the animals. It was concluded that these findings indicate a biochemical parallelism between mitochondria and melanosomes. A possible link between the metabolism of neurotropic amines and the metabolism of melanins and the relation of melanine of the nervous system to Parkinson's disease is discussed. (C.H.)

38707 (COO-1148-85) VOLTAMMETRIC BEHAVIOR OF THE SYSTEM NITROSOBENZENE–PHENYLHYDROXYLAMINE AT THE GRAPHITE ELECTRODE. Laura Chuang, Ilana Fried, and Philip J. Elving (Michigan. Univ., Ann Arbor). July 15, 1964. Contract AT(11-1)-1148. 23p.

The nitrosobenzene–phenylhydroxylamine couple behaves reversibly at the stationary pyrolytic graphite electrode in 50% ethanolic buffered solution. The use of graphite allows the system to be studied at pH as low as 1.6, compared to the limit of pH 4 with the dropping mercury electrode imposed by the oxidation of mercury at the potentials involved. Potentials and currents at the graphite electrode are quite reproducible. The variation of the half-peak po-

tential with pH is represented by 0.33–0.060 pH, in agreement with previous polarographic and potentiometric measurements. The current varies linearly with concentration. Rotating the electrode increases the current as expected but decreases slightly the agreement of the potentials for the reduction of nitrosobenzene and the oxidation of phenylhydroxylamine. Above pH 8, phenylhydroxylamine is rapidly oxidized chemically to nitrosobenzene. At pH 12, nitrosobenzene is also chemically altered. (auth)

38708 (COO-1148-87) ELECTROCHEMICAL BEHAVIOR OF PURINES AND PYRIMIDINES. ANALYTICAL UTILIZATION. Philip J. Elving, William A. Struck, and David L. Smith (Michigan. Univ., Ann Arbor). July 30, 1964. Contract AT(11-1)-1148. 75p.

The behavior of purines and pyrimidines at the dropping mercury electrode (reduction processes) and at the stationary graphite electrode (oxidation processes) is reviewed with emphasis on the reaction paths (mechanisms) involved and on the effects of substituents on the observed behavior patterns and on the reaction paths. The results of electrolysis at controlled electrode potential have been used in interpreting the polarographic patterns. The behavior of a reversible redox system is illustrated by a consideration of the alloxan-alloxantin-dialuric acid system. The frequently greater complexity of reaction path for the electrochemical oxidation of purines and pyrimidines as compared to their electrochemical reduction is illustrated by the oxidation of uric acid, for which a path can be postulated which is generally similar to that postulated for the enzymatic oxidation of uric acid. From systematic study of the electrochemical behavior of purines and pyrimidines, it is often possible to devise electroanalytical procedures, which can be used to follow the course of chemical reactions, to test the effectiveness of fractionation and isolation procedures, and to identify or determine quantitatively purines and pyrimidines, even in mixtures. (auth)

38709 (NAA-SR-Memo-9230) RELIABILITY DEVELOPMENTAL FIXED, SEQUENTIAL AND TRUNCATED SEQUENTIAL TEST PLANS BASED ON THE EXPONENTIAL DISTRIBUTION. T. L. Harman (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 18, 1963. Contract [AT(11-1)-Gen-8]. 29p.

A technique is presented for designing fixed, sequential, and truncated sequential reliability test plans. The method is based on the exponential distribution. The specified minimum acceptable reliability, the risk of concluding that the specification has not been obtained when in fact it has, the risk of concluding that the specification has been obtained when in fact it has not, and the required mission time are the only parameters which must be specified prior to use of this technique to design an applicable test plan. Following presentation of the general method, five specific test plans are presented. The specific plans are normalized in terms of the specified minimum mean-time-between-failures (or its reciprocal, failure rate), which is determined directly from the specified minimum reliability by the exponential formula. Thus, the five specific test plans may be used directly for a particular reliability requirement if the risks used in one of the five plans are acceptable. (auth)

38710 (NP-14226) BIBLIOGRAPHY ON THE HIGH TEMPERATURE CHEMISTRY AND PHYSICS OF MATERIALS IN THE CONDENSED STATE. Volume 1964, Number 2, April–June 1964. J. J. Diamond, ed. (National Bureau of Standards, Washington, D. C.). 69p.

A total of 694 references is presented on devices for obtaining, measuring, and controlling temperatures above 1500°C; devices for physical measurements above 1000°C; high-temperature properties of materials melting above and below 1500°C; phase equilibria; and reactions above 1000°C. (D.L.C.)

38711 (NYO-10544) ADSORPTION OF RADIOACTIVE ZINC AND IRON ON RIVER SILTS. Final Report. Charles E. Renn, John T. O'Connor, and Irmgard Wintner (Johns Hopkins Univ., Baltimore). [1961]. Contract AT(30-1)-2536. 87p.

The behavior of radioactive Zn in rivers and estuaries is determined by the much more abundant normal Zn in these waters. As a basis for predictions on the distribution of radioactive Zn and of excess Zn added in industrial wastes, laboratory studies were carried out on the mechanisms that determine the distribution of Zn in natural surface waters. The effects of pH, silt content, Zn concentration, and other factors on soluble-adsorbed Zn equilibria were measured in samples of water taken from streams of the eastern shore that terminate in the Chesapeake Bay. Data are included on adsorbed Zn on biologically active bottom deposits undergoing anaerobic decomposition. Results are compared with studies on the return of Fe to solution. (C.H.)

38712 (SC-R-64-190) AN ALGORITHM FOR THE CALCULATION OF A CLASS OF FIXED POINTS FOR SERIAL LINEAR SYSTEMS. G. J. Simmons and L. W. Rook (Sandia Corp., Albuquerque, N. Mex.). Apr. 1964. Contract AT(29-1)-789. 25p.

A serial linear system, SLS, is defined to be a sequence of linear equations drawn from a finite set, not necessarily compatible or determinate, in which only a single equation is available at any given time, and where furthermore there is no capability for storing the equations as they occur. Such systems have arisen quite naturally in the investigation of adaptive networks, associative memories, and linear pattern recognition logic. Obviously any procedure which is to solve a SLS must do so iteratively by computations depending only on the currently available element. An algorithm is described, which may be used to solve a SLS if a solution exists, or else to find a fixed point corresponding to a solution point for the compatible case, if the system is overdetermined or incompatible. This algorithm depends on successive orthogonal projections of the approximate solution point Q′ onto the hyperplanes defined by the elements of the SLS. A cycle of these projections, in the instance where the elements of the SLS appear cyclically, is shown to be either a contractive or an identity mapping on any sequence of image points in any hyperplane. (auth)

38713 (SCL-DR-64-90) DESIGN DATA FOR FILAMENT-WOUND STRUCTURES. G. R. Dunbar (Sandia Corp. Livermore Lab., Livermore, Calif.). July 1964. Contract [AT(29-1)-789]. 21p. (SCL-DC-64-89)

Supplement to SCL-DR-64-2.

Results of a 1963–1964 research program to develop design data for filament wound structures are given. A limited investigation was conducted in variables for resin systems, effect of temperature, and sandwich composites. Test results of 18 cylinders are included. (auth)

38714 (TID-19301) PERIODIC PROCESS EVALUATION. Dennis E. Murphy (Sandia Corp., Albuquerque, N. Mex.). June 27, 1963. Contract AT(29-1)-789. 10p.

A plan is described which aids in the economical final production of highly reliable, complex systems that involve too much expense to adequately test during final acceptance testing. The plan involves controlling product variation due to manufacturing causes through the use of rigid process

controls. This is accomplished by mutually establishing minimum process control requirements for selected processes; periodically evaluating actual processing to determine the degree of conformance to minimum control requirements; scoring each evaluated process according to the seriousness of detected discrepancies in relation to their possible affect on product, and the concentration of overall effort and corrective action on those processes indicating unsatisfactory status or condition. (auth)

38715 (JPRS-25741) TRANSLATIONS ON COMMUNIST CHINA'S SCIENCE AND TECHNOLOGY NO. 101. Translated from K'o Hsueh T'ung Pao, No. 5, 441-3; 455-8(May 1964). 225p. (TT-64-41012)

A total of 28 summaries or translations of selected articles is presented. Among the subjects covered are: geology, chemistry, geochemistry, conference reports, agriculture, medicine, biology, etc. Separate abstracts were prepared for three papers dealing with the BeO–La_2O_3 system and with the radiation effects on liver mitochondria. (D.L.C.)

For abstracts of individual papers see: 36958, 37116, and 37117.

38716 DETECTING HIDDEN EXPLOSIVES USING NEUTRON BEAMS. Edward D. Jordan (to U. S. Atomic Energy Commission). U. S. Patent 3,146,349. Aug. 25, 1964.

This patent relates to the use of neutron beam irradiation of luggage for detecting if explosives are contained therein. The detection method may include the tagging at the source of the dynamite or dynamite caps with a neutron absorber such as boron or gadolinium and a detection of gamma rays or neutron depression. (AEC)

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This index contains entries for this period for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

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SUBJECT INDEX

Main entries in this index are generally specific materials, things, and processes. These are followed by modifiers that describe the properties of, and processes applied to, the main entries.

The number preceding the colon is the *NSA* volume number, and the number following is the abstract number. The designation (R) following the abstract number indicates that the abstract is of a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. References to report numbers, where appropriate, are included after the abstract number of the citation. Published literature (journal article or book) is indentifiable by the absence of a report number.

General Indexing Style

The user should bear in mind that the ideas presented in the original literature, rather than key words, have been indexed. The indexers have tried to select what seemed the most probable and logical place to look for typical information. Since it is not possible to anticipate where a user would look for information, numerous cross references are included to assist him in his search.

Experience in using an index of this type will be the best guide in obtaining the desired information, and a consideration of synonymous or closely related terms will prove valuable.

Information must be so indexed as to be of the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use, nor to the general class headings that include the specific headings. For example, information on the treatment of thyroid disease with I-131 would be indexed under Thyroid Diseases and under Iodine Isotopes I-131, but not necessarily under Radiotherapy. A study of the effects of x radiation on hair would be indexed under both X Radiation and Hair. However, the information would not be indexed under the experimental animal, e.g., Rats, unless the report discusses the effects on rat hair as compared with the effect on the hair of other animals.

The broad, general class headings are used only for general information or for comprehensive reports or articles.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings or, in some cases, subheadings; e.g., Amino Acids rather than Acids, amino; Helium Isotopes He-4 rather than Helium—isotopes He-4 or Helium—He-4 isotopes. Note, however, that in some cases modifying terms are used parenthetically in preference to a more direct type of entry which would result in the scattering of information. Organic compounds, however, are usually entered in the index in the inverted form so that substituted compounds can be listed near the parent compound; e.g., Benzene, Bromo- rather than Bromobenzene. In general, the style of nomenclature used is that of *Chemical Abstracts*, except that some items listed in that publication as subheadings are elevated to form part of the main heading; e.g., Butyric Acid, Methyl Ester rather than Butyric Acid—methyl ester.

Alphabetization

Main headings are arranged according to the widely accepted word-by-word alphabetic system. A parenthetic qualifier following a main heading is disregarded in alphabetizing unless there are two or more headings identical except for the parenthetic qualifier, in which case the qualifier determines the order. Headings involving Greek letters are arranged as if the names of the letters were spelled out, e.g., Mesons (π), Mesons (ζ).

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed in the direct form, listing cations in the order of increasing valence in the case of polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., Sodium Aluminum Silicates and Potassium Sodium Sulfates.

Multicomponent Systems

Multicomponent alloys, except well-known trade names are indexed under each element in the alloy.

Example: Aluminum–Chromium Alloys are indexed

ALUMINUM ALLOYS
Al–Cr ...
CHROMIUM ALLOYS
Al–Cr ...

Well-known alloys such as Hastelloy are indexed directly with cross references under the element components. Multicomponent systems of elements are indexed similarly.

Example: Silicon–Tungsten Systems are indexed

SILICON SYSTEMS
Si–W ...
TUNGSTEN SYSTEMS
Si–W ...

Multicomponent systems of compounds are similarly indexed under the compound.

Physical States of Materials

In this subject index specification of the physical state of the material, if other than normal, is included in the modifying phrase.

Modifying Phrases (Subheadings)

Descriptive phrases (modifiers), rather than ordinary subheadings, are used under the main headings to give a better indication of the material covered in an abstract than would be possible with only a word or two whenever it appears that such information would be useful. Such phrases are written so that the idea considered most important is presented first, should a not-too-awkward expression result. However, when using this index, the reader is advised to scan all modifiers under a main heading to determine whether any abstracts in addition to the most obvious should be consulted for the desired information. Many of the modifiers are designed to be read in inverted order or to be read with the main heading inserted at the position of the comma in order to obtain a meaningful phrase; e.g., Uranium—allotropic transformation temperatures of, effect of cooling rate on is read "effect of cooling rate on allotropic transformation temperatures of uranium." In many cases, the prepositions have been omitted from such phrases provided no ambiguity results from the omission.

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Report No.	Abstract No.	Availability
NUMERICAL	**(Misc.)**	
64-RL-3604-M	18-37874	Phys. Rev., 136: B49-58(1964)
A/CONF.28/P–	**(3rd U. N. Int. Conf. on Peaceful Uses of Atomic Energy) (Non-U. S. papers)**	
	The numerical list of reports below is followed by a duplicate list arranged by country.	
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36	18-38386	
37	18-38387	
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40	18-38390	
41	18-38338	
42	18-38574	
43	18-38391	
44	18-38392	
45	18-37868	
46	18-38393	
47	18-38575	
48	18-38576	
49	18-38577	
50	18-37325	
51	18-38339	
52	18-38394	
53	18-38266	
54	18-38395	
55	18-38396	
56	18-37249	
57	18-37645	
58	18-37601	
59	18-37602	
60	18-38355	
61	18-37250	
62	18-37733	
63	18-37630	
64	18-37420	
65	18-38356	
66	18-38357	
67	18-38358	
68	18-37603	
69	18-38397	
70	18-38267	
71	18-37604	
72	18-37399	
73	18-38006	
74	18-38007	
75	18-38296	
76	18-38297	
77	18-38398	
78	18-38578	
79	18-38399	
80	18-38400	
81	18-38401	
82	18-38244	
83	18-37421	
84	18-37866	
85	18-37497	
86	18-38679	
87	18-37392	
88	18-38680	
89	18-37575	
90	18-37576	

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91	18-37577	
92	18-37734	
93	18-37326	
94	18-38402	
95	18-37327	
96	18-38403	
97	18-37735	
98	18-37251	
99	18-38404	
100	18-37252	
101	18-37605	
102	18-38298	
103	18-38579	
870	18-37429	
A/CONF.28/P–	**(Gabon)**	
883	18-37415	
A/CONF.28/P–	**(Greece)**	
569	18-37335	
648	18-38312	
649	18-38313	
854	18-37072	
A/CONF.28/P–	**(Hungary)**	
449	18-37333	
450	18-37264	
451	18-38598	
546	18-38470	
650	18-38314	
651	18-38038	
652	18-38039	
784	18-38688	
855	18-37504	
A/CONF.28/P–	**(IAEA)**	
717	18-38064	
875	18-37395	
876	18-37565	
880	18-37043	
A/CONF.28/P–	**(India)**	
741	18-38704	
744	18-38621	
745	18-38508	
746	18-38509	
749	18-37112	
750	18-37679	
751	18-37657	
752	18-37411	
753	18-37589	
754	18-37590	
785	18-37068	
786	18-37283	
787	18-37284	
788	18-37427	
790	18-38623	
791	18-37502	
792	18-38065	
793	18-38624	
794	18-38689	
820	18-37069	
A/CONF.28/P–	**(International Labor Organization)**	
547	18-37426	
A/CONF.28/P–	**(Israel)**	
506	18-37675	
508	18-37269	
509	18-38036	
510	18-38249	
511	18-38307	
548	18-38547	
666	18-38612	
667	18-38315	
668	18-38041	
755	18-37275	
818	18-37289	
819	18-37290	
825	18-37070	

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826	18-38327	
827	18-38049	
A/CONF.28/P– (Italy)		
549	18-38471	
550	18-38472	
552	18-38473	
554	18-37613	
555	18-37653	
557	18-37586	
558	18-37362	
570	18-38370	
573	18-37676	
574	18-37636	
625	18-38488	
627	18-38489	
629	18-38280	
731	18-38505	
733	18-37656	
735	18-37757	
736	18-38506	
737	18-38507	
795	18-38284	
830	18-37174	
861	18-37073	
864	18-37618	
865	18-38522	
867	18-37343	
871	18-38331	
872	18-38524	
A/CONF.28/P– (Japan)		
120	18-38583	
426	18-38453	
429	18-37353	
430	18-37750	
431	18-37672	
432	18-37649	
433	18-37263	
436	18-38454	
437	18-37059	
438	18-38363	
439	18-37579	
440	18-37580	
577	18-38701	
578	18-38476	
580	18-37336	
582	18-38609	
653	18-38040	
657	18-38235	
664	18-38491	
798	18-37285	
799	18-37615	
843	18-37616	
844	18-37414	
845	18-38344	
846	18-38328	
847	18-38329	
848	18-38330	
849	18-37428	
857	18-37617	
A/CONF.28/P– (Netherlands)		
588	18-38556	
589	18-37337	
590	18-37338	
634	18-37654	
635	18-38251	
636	18-38490	
637	18-37272	
639	18-37588	
724	18-38619	
725	18-38620	
726	18-37756	
727	18-37678	
728	18-38504	
758	18-37276	
800	18-38625	
828	18-37563	

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A/CONF.28/P– (Norway)		
591	18-37637	
592	18-37638	
593	18-38279	
594	18-38478	
595	18-38479	
596	18-38308	
669	18-38316	
748	18-38557	
761	18-37278	
801	18-38558	
859	18-38519	
860	18-38520	
A/CONF.28/P– (Pakistan)		
597	18-38480	
670	18-38613	
671	18-38614	
821	18-37291	
A/CONF.28/P– (Poland)		
112	18-37169	
113	18-37170	
119	18-38582	
488	18-37674	
498	18-38035	
499	18-38306	
500	18-38604	
672	18-38492	
804	18-37286	
805	18-37287	
807	18-38626	
A/CONF.28/P– (Portugal)		
501	18-37408	
503	18-37268	
504	18-37409	
505	18-38605	
598	18-38702	
A/CONF.28/P– (Romania)		
189	18-38586	
480	18-38600	
673	18-38042	
674	18-38549	
675	18-38317	
676	18-38615	
677	18-38282	
A/CONF.28/P– (South Africa)		
464	18-37110	
465	18-37582	
599	18-38481	
600	18-37339	
836	18-37293	
853	18-36909	
A/CONF.28/P– (Spain)		
490	18-37755	
491	18-37584	
492	18-38603	
493	18-37651	
494	18-37407	
495	18-38456	
496	18-37585	
497	18-37562	
601	18-38482	
678	18-38043	
742	18-38325	
743	18-38326	
863	18-38521	
A/CONF.28/P– (Sweden)		
416	18-37499	
417	18-38452	
418	18-37262	
419	18-37610	
420	18-37749	
602	18-38483	
603	18-38484	

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604	18-38703	
605	18-38485	
606	18-38486	
607	18-37340	
608	18-38487	
609	18-38684	
610	18-37500	
611	18-37393	
679	18-38493	
680	18-38044	
681	18-38045	
682	18-38494	
683	18-38495	
684	18-38236	
685	18-38318	
808	18-38285	
809	18-38515	
810	18-38516	
A/CONF.28/P– (Switzerland)		
459	18-38455	
460	18-37752	
686	18-38319	
687	18-38496	
688	18-38046	
690	18-38320	
691	18-38321	
692	18-38497	
693	18-38498	
694	18-38499	
695	18-38253	
696	18-38500	
697	18-38501	
757	18-37680	
A/CONF.28/P– (Tunisia)		
824	18-38517	
A/CONF.28/P– (Turkey)		
747	18-38622	
856	18-36947	
A/CONF.28/P– (Ukrainian SSR)		
615	18-38610	
616	18-37501	
766	18-37363	
A/CONF.28/P– (Union of Soviet Socialist Republics)		
294	18-38431	
295	18-38432	
296	18-38587	
297	18-38200	
304	18-38433	
305	18-38434	
306	18-38435	
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308	18-38437	
309	18-38438	
310	18-38439	
311	18-38440	
312	18-38588	
313	18-38552	
314	18-38441	
316	18-38442	
317	18-37871	
318	18-37872	
319	18-38443	
320	18-38589	
321	18-38590	
322	18-38591	
322a	18-38592	
323	18-38593	
324	18-38594	
325	18-38595	
326	18-37331	
327a	18-37330	
328	18-38444	
329	18-37332	
330	18-38273	
331	18-38274	
333	18-37669	
336	18-37647	
337	18-37670	
338	18-37742	
338a	18-37743	
338b	18-37744	
339	18-37745	
339a	18-37746	
340	18-37608	
341	18-37632	
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343	18-37634	
344	18-37256	
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348	18-37260	
349	18-37108	
350	18-37609	
351	18-37648	
353	18-37109	
354	18-38275	
355	18-38445	
356	18-38008	
357	18-38009	
358	18-37862	
359	18-38446	
360	18-38031	
361	18-38303	
362	18-38304	
362a	18-38032	
363	18-38234	
364	18-38340	
365	18-38010	
366	18-38011	
367	18-38012	
368	18-38013	
369	18-38447	
371	18-38448	
373	18-38341	
374	18-38305	
375	18-38342	
376	18-38449	
377	18-38062	
378	18-37423	
379	18-37424	
380	18-38450	
381	18-37867	
382	18-38451	
383	18-37789	
383a	18-37790	
384	18-37359	
385	18-37360	
386	18-36946	
388	18-37578	
389	18-37171	
512	18-37270	
583	18-38063	
585	18-38477	
587	18-38683	
873	18-38525	
877	18-38526	
878	18-38332	
A/CONF.28/P– (United Arab Republic)		
453	18-38599	
454	18-37404	
455	18-37265	
456	18-37266	
457	18-37581	
458	18-37172	
811	18-36917	
812	18-37029	
813	18-37288	
814	18-37060	
816	18-38550	
823	18-37292	
829	18-37071	
840	18-37394	

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841	18-36919	
A/CONF.28/P–	**(United Kingdom)**	
121	18-38405	
122	18-38406	
123	18-38584	
124	18-38407	
125	18-38408	
126	18-38409	
127	18-38410	
128	18-38411	
129	18-38412	
130	18-38413	
131	18-38414	
132	18-37869	
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134	18-38585	
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136	18-37329	
137	18-38415	
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140	18-38270	
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142	18-38417	
143	18-38418	
144	18-38271	
145	18-37736	
146	18-37667	
147	18-38359	
148	18-37737	
149	18-38360	
150	18-38419	
151	18-37646	
152	18-37606	
153	18-38361	
154	18-38362	
155	18-37738	
156	18-37607	
157	18-37631	
158	18-37668	
159a	18-38420	
159b	18-37253	
160	18-37254	
161	18-37255	
162	18-37739	
163	18-37740	
164	18-37400	
165	18-38299	
166	18-38300	
167	18-37741	
168	18-37597	
169	18-38301	
170	18-38421	
171	18-38422	
172	18-38302	
173	18-38423	
174	18-38424	
175	18-38425	
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179	18-38428	
180	18-38272	
181	18-38246	
182	18-38429	
183	18-38430	
184	18-37422	
185	18-38247	
186	18-38248	
187	18-38681	
188	18-38682	
559	18-38474	
560	18-37614	
561	18-38475	
562	18-37271	
564	18-38250	
565	18-38555	
566	18-37173	
567	18-37587	

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A/CONF.28/P–	**(World Meteorological Organization)**	
714	18-37791	
A/CONF.28/P–	**(Yugoslavia)**	
412	18-37748	
414	18-37261	
415	18-37403	
698	18-37341	
699	18-37342	
700	18-37655	
701	18-37677	
702	18-37111	
703	18-37273	
704	18-37274	
705	18-38616	
706	18-38322	
707	18-38323	
708	18-38047	
709	18-38617	
858	18-38345	
AD–	**(Misc.)**	
406623	18-37518	See USAELRDL-TR-2334
418409	18-37163	$1.10(OTS)
424651	18-37661	See ASD-TDR-63-799(Pt.I)
431995	18-37430	$1.60(OTS)
432234	18-37473	See ASD-TDR-63-75
433192	18-37305	See RTD-TDR-63-3041(Vol.IV)
434058	18-37164	$2.60(OTS)
435972	18-37792	See NEL-1207
436294	18-37304	See APL-TDR-64-42
437260	18-37619	$5.60(OTS)
438147	18-37431	$8.10(OTS)
438177	18-36948	$22.25(OTS)
438178	18-36949	$22.25(OTS)
438181	18-38016	$14.00(OTS)
438520	18-37165	$12.50(OTS)
439251	18-37432	$12.00(OTS)
600057	18-37510	See BRL-Memo-1545
600228	18-37030	$0.50(OTS)
600229	18-37031	$0.50(OTS)
600297	18-37505	$1.00(OTS)
600369	18-37863	See AFCRL-64-394
600423	18-37433	$0.50(OTS)
600437	18-37434	$2.75(OTS)
600447	18-37365	$1.25(OTS)
600542	18-38203	$1.00(OTS)
600574	18-37344	$2.50(OTS)
600707	18-37516	See SRB-63-7
600751	18-37435	$2.25(OTS)
603309	18-37447	See USNRDL-TR-761
603414	18-38240	See TO-B-64-44
603625	18-38014	See AFCRL-64-529
AEC-tr–		
6398	18-37571	Dep.; $8.64(cy), 9(mn) OTS
6446	18-37372	Dep.(mc); $4.60(fs), $1.49(mf) OTS
AECL–	**(Canadian)**	
1923	18-38256	See RPI-75
AED-C–	**(German)**	
02-05	18-37436	Dep.(mc)
04-15	18-36950	Dep.(mc)
14-03	18-37074	Dep.(mc)
22-02	18-38559	Dep.(mc)
AEET-CD–	**(Indian)**	
20	18-37175	Dep.(mn)
AEET-HP–	**(Indian)**	
RWD/4	18-38690	Dep.(mn)
SM-1	18-37437	Dep.(mn)
AERE-AM–	**(British)**	
99	18-37075	Dep.; $0.30(BIS); 1s. 9d. (HMSO)
AERE-M–	**(British)**	
1397	18-37310	Dep.; $0.50(BIS); 2s. 6d. (HMSO)

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AERE-R–	**(British)**	
3757	18-37873	Dep.(mc)
4340	18-37345	Dep.; $0.60(BIS); 3s. (HMSO)
4428	18-37701	J. Nucl. Mater., 12: 16-23(1964)
4463	18-37776	J. Nucl. Mater., 12: 56-60(1964)
4643	18-37506	Dep.; $0.70(BIS); 3s. 6d. (HMSO)
4680	18-37438	Dep.; $0.70(BIS); 3s. 6d. (HMSO)
AFCRL–	**(Non-AEC)**	
64-394	18-37863	$2.00(OTS)
64-496	18-37114	
64-529	18-38014	$3.00(fs), $0.75(mf) OTS
ANL–		
6703	18-38527	Dep.; $8.72(cy), 10(mn) OTS
6856	18-37115	Dep.; $3.00(cy), 1(mn) OTS
6876	18-37660	Dep.; $0.50(OTS)
ANL-Trans–		
76	18-37449	Dep.(mn); $1.10(fs), $0.80(mf) JCL
APCI–		
541301	18-38017	Dep.(mc); $14.50(fs), $6.65(mf) OTS
APDA–	**(Misc.)**	
160	18-38533	Dep.; $1.25(OTS)
APL-TDR–	**(Non-AEC)**	
64-42	18-37304	OTS
ASD-TDR–	**(Non-AEC)**	
63-75	18-37473	$2.75(OTS)
63-799(Pt.I)	18-37661	
ATN–	**(Non-AEC)**	
64(9230)-2	18-38204	
AWRE-NR–	**(British)**	
2/64	18-37507	Dep.(mn)
AWRE-O–	**(British)**	
37/64	18-38066	Dep.(mc)
61/64	18-38067	Dep.(mn)
BAW–	**(Misc.)**	
3125-1	18-38373	Dep.(mn); $1.00(cy), 1(mn) OTS
BM-RI–	**(Misc.)**	
6510	18-37295	Free(Bureau of Mines)
BMI–	**(Misc.)**	
1683	18-37759	Dep.; $2.00(cy); 1(mn) OTS
BNL–		
874	18-37176	Dep.; $3.00(cy), 1(mn) OTS
6683	18-37017	p.203-37 of "Atomic Medicine. Fourth Edition." Baltimore, Williams and Wilkins Co., 1964
7608	18-36994	Radiation Botany, 4: 127-39(1964)
7902	18-37167	J. Org. Chem., 29: 2394-7(1964)
7946	18-37129	J. Chem. Phys., 41: 1654-61(1964)
7952	18-37134	J. Chem. Phys., 41: 1789-98(1964)
7972	18-37135	J. Chem. Phys., 41: 1799-1807(1964)
8236	18-37875	Dep.(mn); $1.00(cy), 1(mn) OTS
8248	18-37876	Dep.(mn); $1.00(cy), 1(mn) OTS
8252	18-38706	Dep.(mn); $1.00(cy), 1(mn) OTS
BRL-Memo–	**(Misc.)**	
1545	18-37510	$0.50(OTS)
CERN–	**(European Organization for Nuclear Research)**	
64-33	18-37877	Dep.(mc)
CEX–		
62.81(Final)	18-37366	Dep.; $3.00(cy), 2(mn) OTS
CLOR–	**(Polish)**	
27	18-37474	Dep.
CONF-232	**18-37138**	**(International Colloquy on Neutron Diffusion and Diffraction, Grenoble, France, Sept. 1963)**
CONF-282–		**(Aerospace Reliability and Maintainability Conference, Washington, D. C., June-July 1964)**
1	18-38564	See SC-DC-3409
CONF-288	**18-37812**	**(2nd Conference on Kinetics Equilibria and Performance of High Temperature Systems, Western States Section of the Combustion Institute, Los Angeles, Apr. 1962)**
CONF-337–		**(International Conference on Radioactive Pollution of Gaseous Media, Saclay, France, Nov. 1963)**
7	18-37439	Dep.(mn)
35	18-37391	ORINS
36	18-37865	ORINS
38	18-36945	ORINS
45	18-37367	Dep.(mn); 2.00(cy), 1(mn) OTS
CONF-448–		**(IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, Ger., May 1964)**
22	18-37106	ORINS
23	18-36943	ORINS
24	18-36944	ORINS
CONF-497–		**(3rd United Nations International Conference on Peaceful Uses of Atomic Energy)**
See A/CONF.28/P-		
CONF-550–		**(The International Conference on High-Energy Physics, Dubna, Aug. 1964)**
9	18-37884	See UCRL-11442
10	18-37819	See UCRL-11438
11	18-37888	See UCRL-11550
12	18-37517	See UCRL-11425
15	18-37820	See UCRL-11527
17	18-37889	See UCRL-11553
18	18-37887	See UCRL-11500
19	18-37886	See UCRL-11468
22	18-37883	See UCRL-11441
27	18-37882	See UCRL-11437
28	18-37876	See BNL-8248
29	18-37875	See BNL-8236
41	18-37885	See UCRL-11465
COO–		
7-330	18-38121	Nucl. Phys., 59: 235-40(1964)
1148-85	18-38707	Dep.(mn); $2.00(cy), 1(mn) OTS
1148-87	18-38708	Dep.(mn); $3.00(cy), 2(mn) OTS
1195-9	18-37542	Rev. Sci. Instr., 35: 1360-1(1964)
DCBRL–	**(Canadian)**	
435	18-36966	Can. J. Biochem., 42: 1233-43(1964)
DSR–	**(Non-AEC)**	
8734-2	18-37344	See AD-600474
ETR–	**(Belgian)**	
105	18-37370	See NP-12548
EUR–	**(European Atomic Energy Community)**	
1641.i	18-37063	Dep.(mc)
1848.e	18-37796	Dep.(mc)
EURAEC–		
1082	18-37681	Dep.(mn); $3.00(cy), 1(mn) OTS
1103	18-37763	Dep.(mn); $1.00(cy), 1(mn) OTS
1130	18-37639	Dep.(mn); $1.00(cy), 1(mn) OTS
1146	18-38373	See BAW-3125-1
1171	18-37346	See GEAP-4631
GEAP–	**(Misc.)**	
4631	18-37346	Dep.(mc); $9.10(fs), $3.35(mf) OTS
HMS–		
1229-46	18-37368	Dep.(mn); $2.00(cy), 1(mn) OTS
HW–		

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75359	18-37640	Dep.(mn); $1.00(cy), 1(mn) OTS
76460	18-37312	Dep.(mn); $1.00(cy), 1(mn) OTS
82409	18-36920	Dep.; $2.00(cy), 1(mn) OTS
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